SOIL SURVEY OF

Hanson and Hutchinson Counties, South Dakota

United States Department of Agriculture
Soil Conservation Service
In cooperation with
South Dakota Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1965 to 1974. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1974. This survey was made cooperatively by the Soil Conservation Service and the South Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Hanson County Conservation District and the Hutchinson County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Hanson and Hutchinson Counties are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map soil areas are outlined and are identified by a symbol. All areas marked with the same symbol are the same kind of soil.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the survey area in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the pasture group, windbreak group, and range site in which the soil has been placed.

Maps showing the suitability or degree of limitation of the soils for specific uses can be developed by using the soil map and information in the text. Translucent material can be used as an overlay on the soil map and colored to show the soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

Farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, the pasture groups, the range sites, and the windbreak groups.

Foresters can refer to the section "Native Woods and Windbreaks," where the soils of the survey area are grouped according to their suitability for trees.

Game managers can find information about soils and wildlife in the section "Wildlife."

Ranchers can find, under "Range," groupings of the soils according to their suitability for range and the names of plants that grow on each range site.

Engineers and builders can find, in the sections about engineering, tables that give soil test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists can learn about the soils in the survey area in the section "Formation and Classification of Soils."

Newcomers in Hanson and Hutchinson Counties may be interested in the section "General Soil Map," where broad patterns of soils are described, and in the section "Environmental Factors Affecting Soil Use."

Cover: Aerial view of a farmstead windbreak in Hanson County on Prosper-Clarno loams, 0 to 2 percent slopes.

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Issued August 1978

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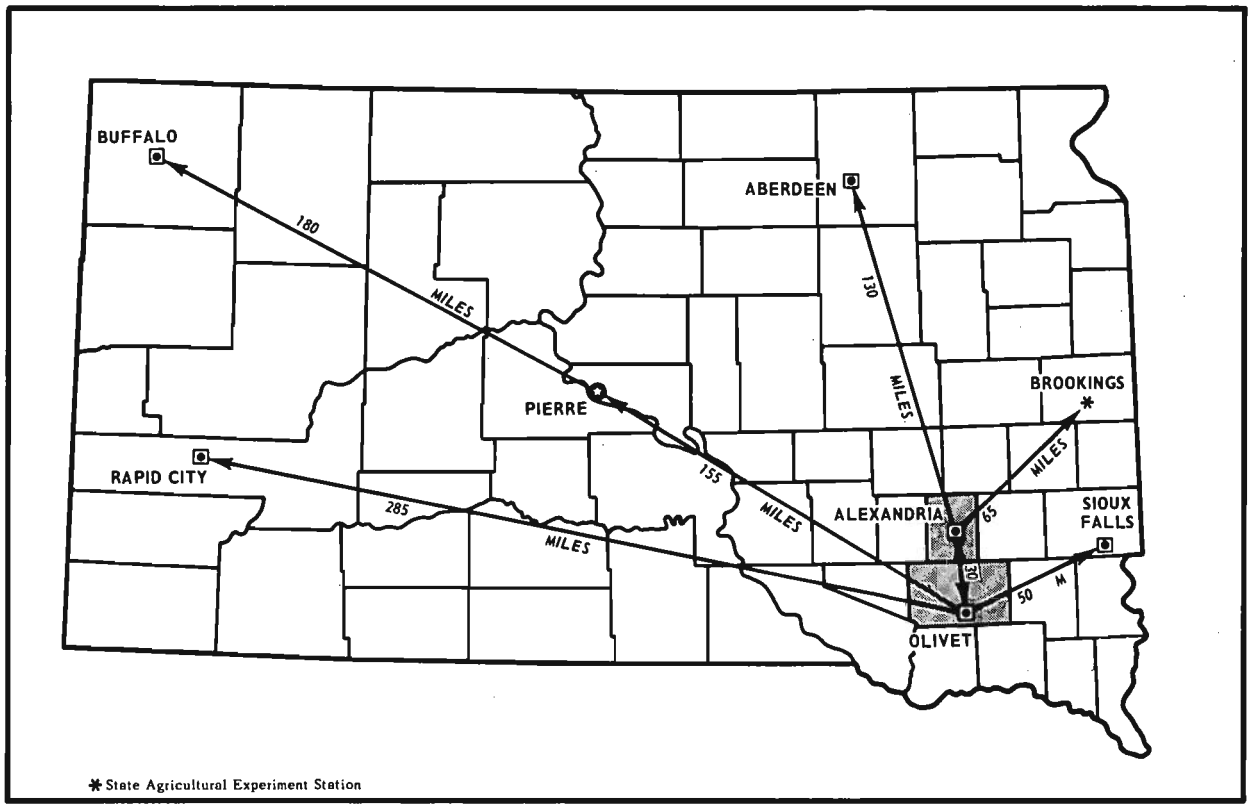

Location of Hanson and Hutchinson Counties in South Dakota.

SOIL SURVEY OF HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA

By Warren F. Johnson, Soil Conservation Service
Soils surveyed by Warren F. Johnson, Maurice J. Mausbach, Regis L. Vialle, and Elmer M. Ward, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with South Dakota Agricultural Experiment Station

HANSON and HUTCHINSON COUNTIES are in the southeastern part of South Dakota. The total area of the two counties is 797,440 acres or about 1,246 square miles. Alexandria is the county seat of Hanson County. Olivet is the county seat of Hutchinson County. Parkston is the largest town in the survey area. Other incorporated towns and villages are Dimock, Emery, Farmer, Freeman, Fulton, Kaylor, Menno, and Tripp.

Most of this survey area is within the James River Lowlands, a subdivision of the Central Lowlands physiographic province. This glacial plain is mostly nearly level to undulating and has many small depressions or potholes. The southern part of Hanson County and the central part of Hutchinson County are mostly undulating to gently rolling. The relief is gently rolling to hilly in the southwestern and southeastern parts of Hutchinson County and is hilly to steep in the breaks along the James River.

The James River and its tributaries drain most of the survey area. The river enters the west side of Hanson County and flows southeasterly, leaving the survey area about 5 miles southeast of Olivet. The southwest corner of Hutchinson County is drained by Choteau and Emanuel Creeks, which flow south to the Missouri River. The eastern edge of Hutchinson County is drained by Clay and Turkey Creeks, which flow southeasterly to the Vermillion River.

Livestock farming is the main enterprise. About 75 percent of the survey area is cropland. Corn, oats, alfalfa, sorghum, soybeans, and tame grasses are the main crops. Much of the crop production is used to feed cattle and hogs, but some is marketed. Controlling erosion, maintaining fertility and tilth, and reducing wetness on poorly drained soils are the main concerns of management.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a detailed soil map are called mapping units. Some mapping units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Mapping units are discussed in the section "Description of the Soils."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that

it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General Soil Map

The general soil map at the back of this publication shows, in color, the soil associations in the survey area. A soil association is a unique natural landscape that has a distinct pattern of soils and of relief and drainage. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one association differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

The soil associations in this survey area are described in the pages that follow. The names and boundaries of the soil associations do not coincide exactly with those in previously published surveys of adjacent counties. This is because of differences in detail of the general soil map and also because of changes in the application of the soil classification system.

The terms for texture used in the descriptive headings of the associations apply to the texture of the surface layer. For example, in the heading for the Clarno-Tetonka-Prosper association, "loamy" and "silty" refer only to the texture of the surface layer.

1. *Ethan-Betts-Chaska association*

Well drained to excessively drained, rolling to steep, loamy soils that formed in glacial till on uplands; and somewhat poorly drained and poorly drained, nearly level, silty and loamy soils on bottom land

This association consists of stream breaks and bottom land along the James River and its tributaries. Slopes are mostly hilly to steep on the breaks and are dissected by many drainageways that terminate in fans at the edge of the stream valley. Stones and boulders are on some ridges. The bottom land is nearly level.

This association makes up about 11 percent of the survey area. It is about 25 percent Ethan soils, 20 percent Betts soils, and 20 percent Chaska soils (fig. 1). Minor soils make up the rest.

Ethan soils are well drained. They are mostly rolling to steep and are in the middle part of the breaks. These soils have a surface layer of dark grayish brown loam. The layer below that is light brownish gray calcareous loam. The underlying material is light yellowish brown calcareous loam.

Betts soils are well drained to excessively drained. They are rolling to steep and are mostly in the higher part of the breaks. They are similar to Ethan soils except that they have a thinner surface layer.

Chaska soils are on bottom lands. They are nearly level and are somewhat poorly drained and poorly drained. They are subject to flooding and have a seasonal high water table. They have a very thick surface layer of very dark gray silt loam and loam. The underlying material to a depth of 47 inches is dark gray, calcareous, fine sandy loam. Gray and grayish brown, calcareous loamy fine sand is at a depth of 47 inches.

Minor soils in this association include Bon soils on high bottoms; Clamo, James, Lamo, Salmo, and Wann soils on bottom lands along the James River; Clarno and Davis soils on foot slopes and fans below Ethan and Betts soils; and Delmont and Talmo soils, which are underlain by gravelly sand, on ridges and knolls.

Runoff is medium to rapid on the Ethan and Betts soils in this association, and the hazard of erosion is very severe if the plant cover is removed. These soils are medium to low in fertility. Runoff is slow on the Chaska soils, and there is a slight hazard of erosion. The hazard of erosion on Ethan and Betts soils and wetness from flooding and from a seasonal water table on Chaska soils are the main concerns of management.

Most areas of Ethan and Betts soils remain in native grass and are used for pasture. The larger tracts of Chaska soils and other bottom land soils are farmed. Corn, sorghum, and alfalfa are the main crops. Livestock production is the main enterprise. Feed and forage crops are produced on the bottom lands for use by beef cattle and hogs. A few dairy farms are in areas of this association.

2. *Homme-Onita-Whitewood association*

Well drained to somewhat poorly drained, nearly level to moderately sloping, silty soils that formed in glacial drift and alluvium on uplands.

This association is on uplands in southwestern Hutchinson County. It is characterized by broad flats and gentle rises that are broken by poorly defined drainageways and many closed depressions. The soils are mostly nearly level and gently sloping, but some are moderately sloping.

This association makes up about 3 percent of the survey area. It is about 30 percent Homme soils, 15 percent Onita soils, and 15 percent Whitewood soils. Minor soils make up the rest.

Homme soils are well drained and nearly level to moderately sloping. They have long, smooth slopes that are plane to convex. The surface layer is dark grayish brown silty clay loam. The subsoil is brown and light olive brown silty clay loam in the upper part and light yellowish brown, calcareous silt loam in the lower part. The underlying material is light yellowish brown, calcareous loam.

Onita soils are moderately well drained and nearly level to gently undulating. Slopes are concave. These soils are in shallow swales and on foot slopes. The sur-

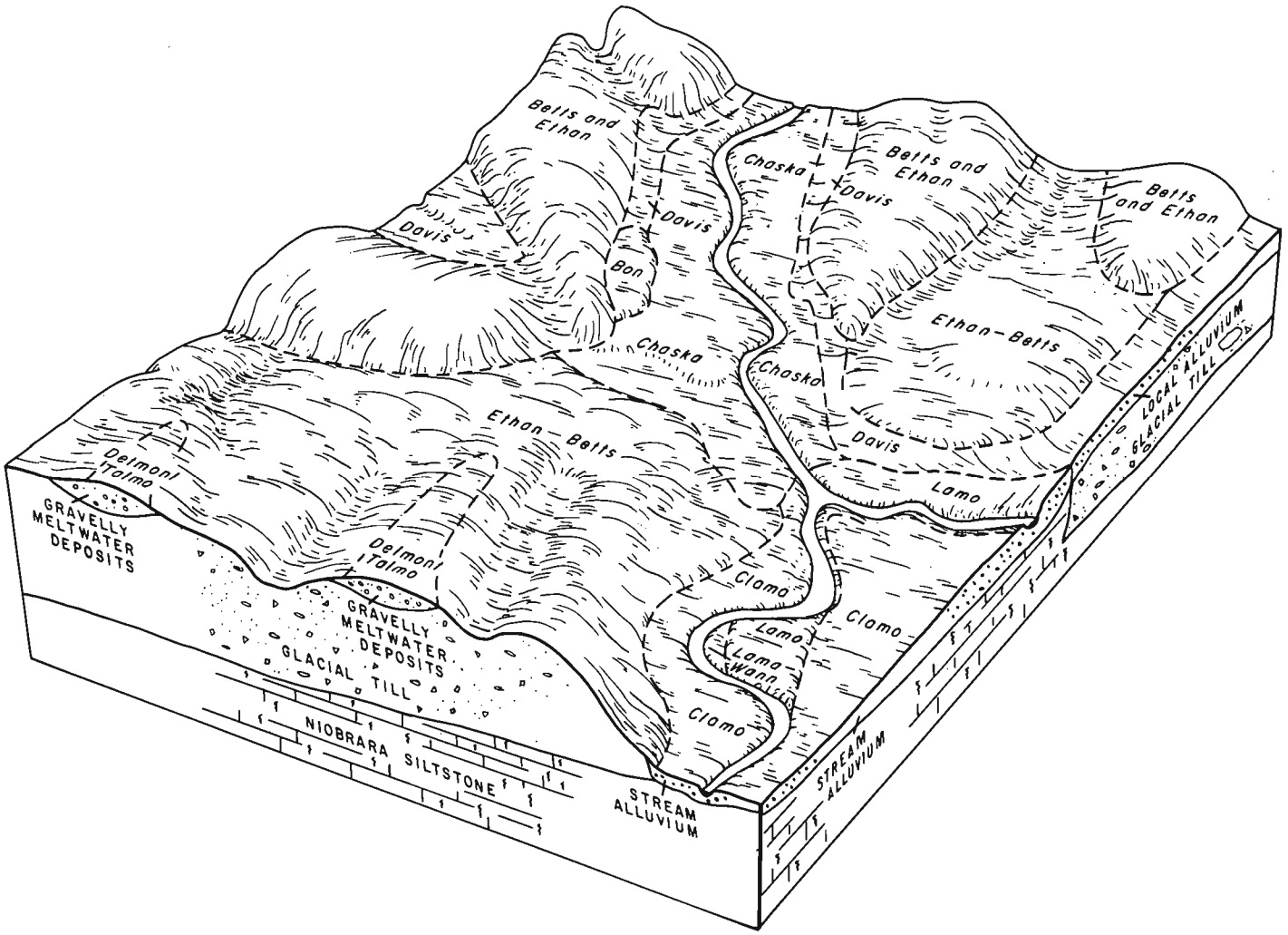

Figure 1.—**Pattern of soils and geologic material in association 1.**

face layer is dark grayish brown silt loam. The subsoil is dark gray and grayish brown silty clay loam. The underlying material is light yellowish brown and gray calcareous clay loam.

Whitewood soils are somewhat poorly drained and are nearly level. They are in swales and along poorly defined drainageways. The surface layer is very dark gray silty clay loam and silt loam. The subsoil is dark gray silty clay loam in the upper part, dark grayish brown loam in the middle part, and grayish brown loam in the lower part. The underlying material is light brownish gray, calcareous silt loam and clay loam.

Minor soils in this association include Betts and Ethan soils on some ridges above the Homme soils and on the sides of entrenched drainageways, Davison soils on rises immediately above Onita soils, and Tetonka soils in closed depressions.

Runoff is slow to medium and the erosion hazard is slight to severe, depending on the degree of slope. The major soils are medium to high in fertility. Farming is delayed on the Onita and Whitewood soils because of spring wetness. Controlling water erosion and wetness in spring are the main management concerns.

Most areas are cultivated. These soils are well suited to all crops grown in the county, but in some years, Whitewood soils are better suited to late-planted row crops than to small grain. Livestock production is the main enterprise. Most of the crops are grown for use by beef cattle and hogs. A few dairy farms are in areas of this association.

3. *Egan-Wentworth association*

Well drained, gently sloping and moderately sloping, silty soils that formed in glacial drift on uplands

This association is on uplands in southeastern Hutchinson County. The soils are mostly gently sloping to moderately sloping. Slopes are long and smooth. Steeper soils are along some of the entrenched drainageways that cut back into the area. A few closed depressions are in the area, but the drainage pattern is moderately well defined.

This association makes up about 1 percent of the survey area. It is about 45 percent Egan soils and 25 percent Wentworth soils (fig. 2). Minor soils make up the rest.

Egan soils are mainly in the higher parts of the landscape. The surface layer is dark grayish brown silt loam. The subsoil is silty clay loam that is brown in the upper part, yellowish brown in the middle part, and light yellowish brown and calcareous in the lower part. The underlying material is calcareous silty clay loam and clay loam.

Wentworth soils are in the lower parts of the landscape where slopes are plane to concave. They are similar to Egan soils except that the underlying material in Wentworth soils is silty to a greater depth.

Minor soils in this association include Betts, Clarno, and Ethan soils on some ridges and on the sides of entrenched drainageways; Hand and Henkin soils in areas that are underlain by glacial melt-water deposits; Tetonka and Worthing soils in closed depressions; and Whitewood soils in swales and along some of the drainageways.

Runoff is medium. The major soils in this association are medium to high in fertility. Controlling erosion is the main management concern.

Most areas are cultivated. The major soils are well suited to all crops grown in the county. Corn, oats, sorghum, soybeans, and alfalfa are the main crops. Livestock production is the main enterprise. Most of the crops are grown for use by beef cattle and hogs, but soybeans and some corn are grown for marketing.

4. *Prosper-Clarno-Stickney association*

Moderately well drained and well drained, nearly level to undulating, loamy and silty soils that formed in alluvium and glacial till on uplands

This association consists of broad flats that are broken by swales, drainageways, slight rises, and closed depressions. The soils are mostly nearly level, but some are undulating. Some of the larger drainageways head in these areas, but in places the drainage pattern is poorly defined.

This association makes up about 24 percent of the survey area. It is about 30 percent Prosper soils, 30 percent Clarno soils, and 10 percent Stickney soils (fig. 3). Minor soils make up the rest.

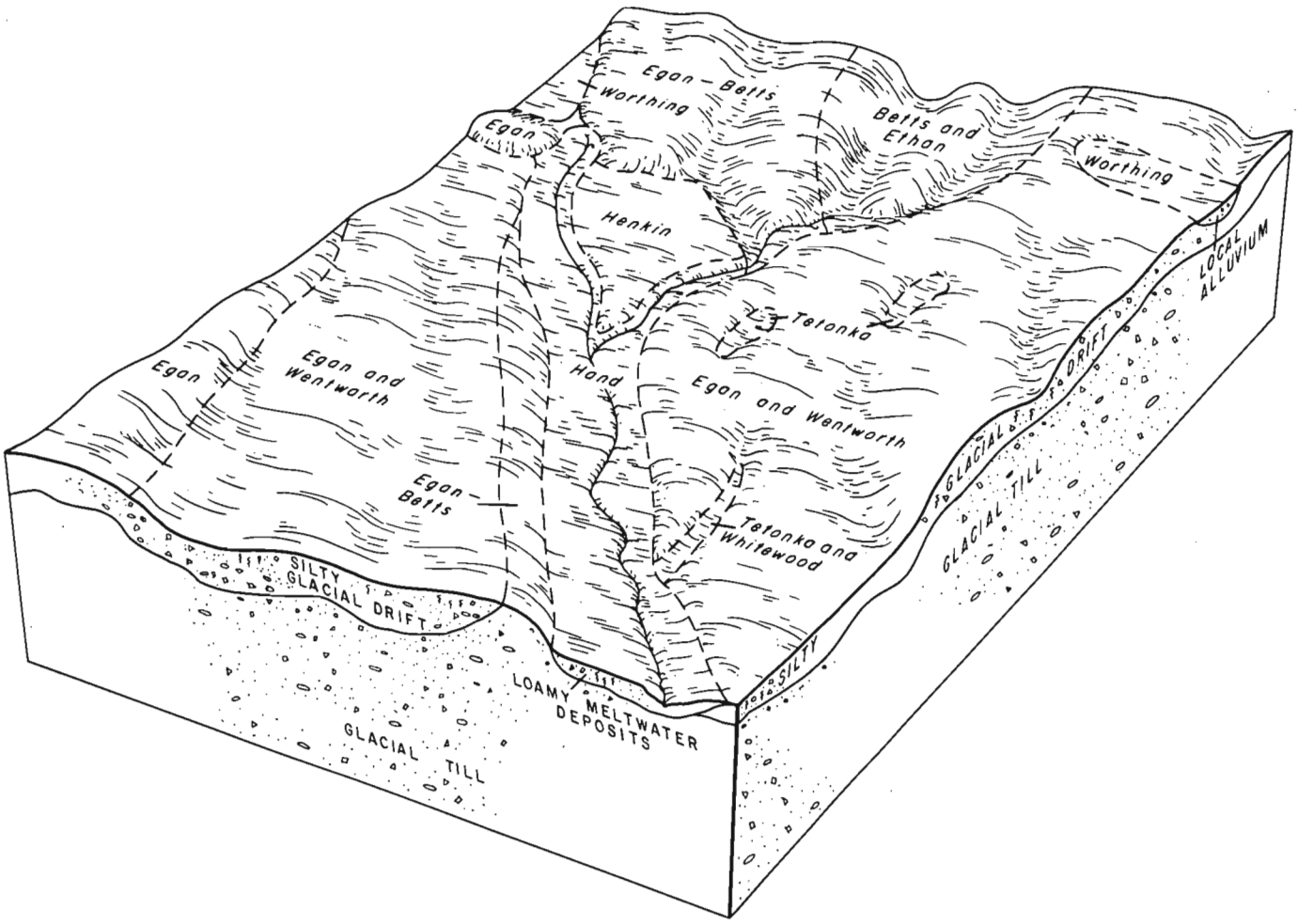

Figure 2.—Pattern of soils and geologic material in association 3.

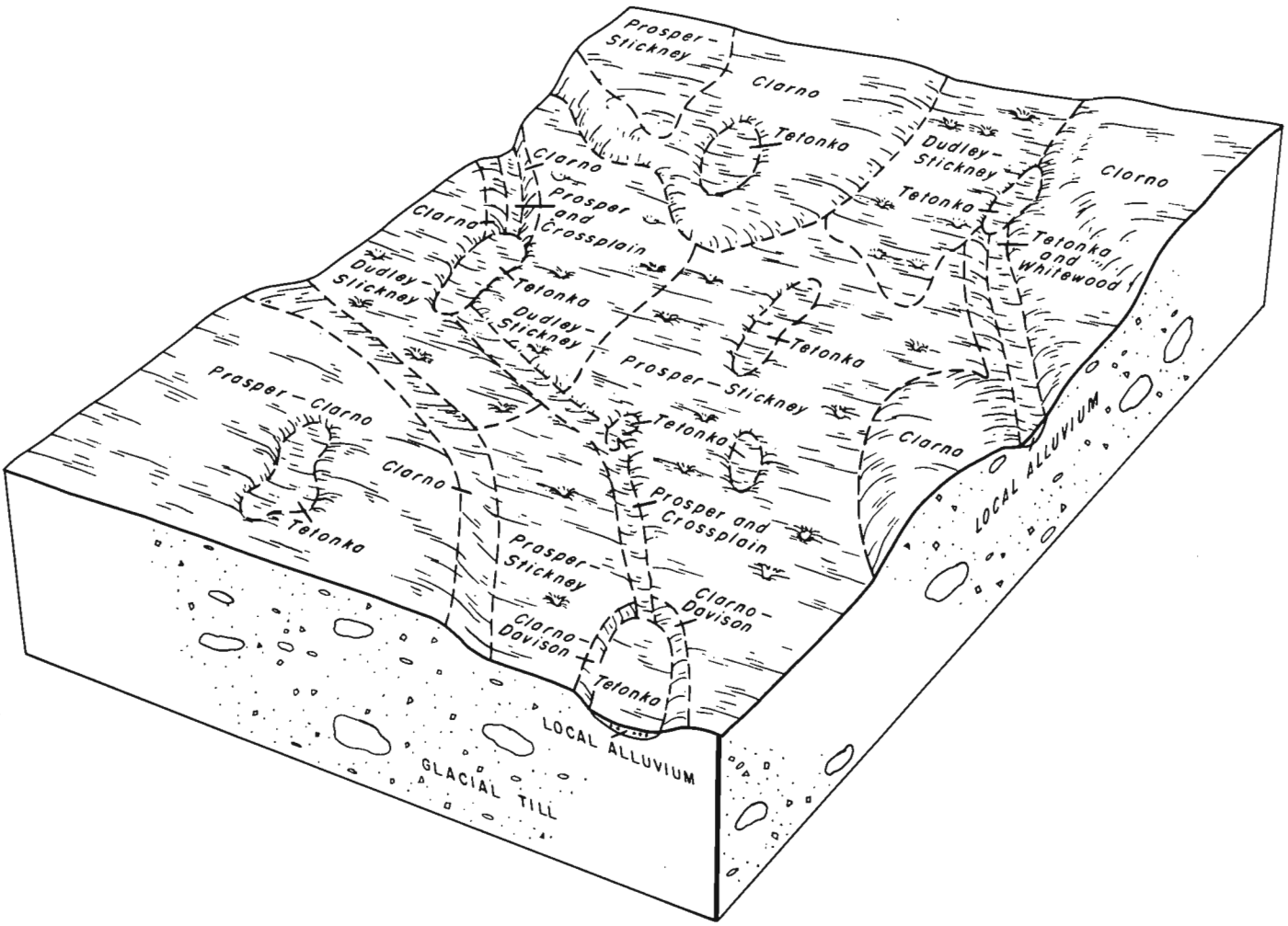

Figure 3.—**Pattern of soils and geologic material in association 4.**

Prosper soils are moderately well drained and nearly level. They are in the shallow swales and concave parts of broad flats. The surface layer is thick and is dark grayish brown and dark gray loam. The subsoil is dark gray loam in the upper part and light olive brown and grayish brown clay loam in the middle part. The lower part of the subsoil and the underlying material are light brownish gray, calcareous loam.

Clarno soils are well drained and nearly level to undulating. They are on slight rises. The surface layer is dark gray loam. The subsoil is dark grayish brown clay loam in the upper part and grayish brown loam in the middle part. The lower part of the subsoil and the underlying material are pale yellow and light yellowish brown, calcareous loam.

Stickney soils are moderately well drained and nearly level. They are on very slight rises. The surface layer is dark gray silty clay loam. The subsurface layer is grayish brown silt loam and is underlain by a claypan subsoil. The claypan subsoil is firm silty clay loam that is dark gray in the upper part and light brownish gray in the lower part. The underlying material is calcareous clay loam.

Minor soils in this association include Crossplain and Whitewood soils in some of the swales; Davison and Hand soils on some rises; Dudley soils on some flats closely intermingled with Stickney soils; and Tetonka soils in closed depressions and in low parts of some drainageways.

Runoff is slow in much of this association, but it is medium in some areas of the Clarno soils. Farming in the lower parts of the landscape is delayed in some years because of wetness in spring, but in most years drainage is adequate for crops. Clarno and Prosper soils have few or no limitations for crops, but the Stickney soils absorb water slowly and release moisture slowly to plants. Maintaining fertility and tilth on the major soils, improving the water intake of the Stickney soils, and controlling erosion on the steeper rises of the Clarno soils are the main management concerns.

Most areas are cultivated. Corn, oats, soybeans, sorghum, and alfalfa are the main crops. Livestock

production is the main enterprise. Some of the corn and soybeans are grown for marketing, but much of the feed and forage crops are grown for use by beef cattle and hogs. A few dairy farms are in areas of this association.

5. *Clarno-Tetonka-Prosper association*

Well drained, poorly drained, and moderately well drained, level to undulating, loamy and silty soils that formed in glacial till and alluvium on uplands

This association consists of a glacial plain that has very gentle swells and swales with differences in elevation of less than 20 feet. The low undulations are interspersed with poorly defined drainageways and many closed depressions. The soils are mostly nearly level to gently undulating. Steeper soils are on the sides of some of the drainageways and depressions. The drainage pattern in many areas is poorly defined.

This association makes up about 32 percent of the survey area. It is about 50 percent Clarno soils, 20 percent Tetonka soils, and 10 percent Prosper soils (fig. 4). Minor soils make up the rest.

Clarno soils are well drained and mostly nearly level to undulating. They are on very slight rises and formed in glacial till. The surface layer is dark gray loam. The subsoil is dark grayish brown clay loam in the upper part and grayish brown loam in the middle part. The lower part of the subsoil and the underlying material are pale yellow and light yellowish brown, calcareous loam.

Tetonka soils are poorly drained and level and nearly level. They formed in local alluvium. They are in closed depressions and in some of the wider entrenched drainageways. The surface layer is dark gray silty clay loam. The subsurface layer is gray silt loam. The subsoil is dark gray and grayish brown silty clay. The underlying material is gray and light gray, calcareous clay loam and loam.

Prosper soils are moderately well drained and nearly level. They are in shallow swales or concave low areas on flats. The surface layer is thick and is dark grayish brown and dark gray loam. The subsoil is dark gray loam in the upper part and light olive brown and grayish brown clay loam in the middle part. The lower

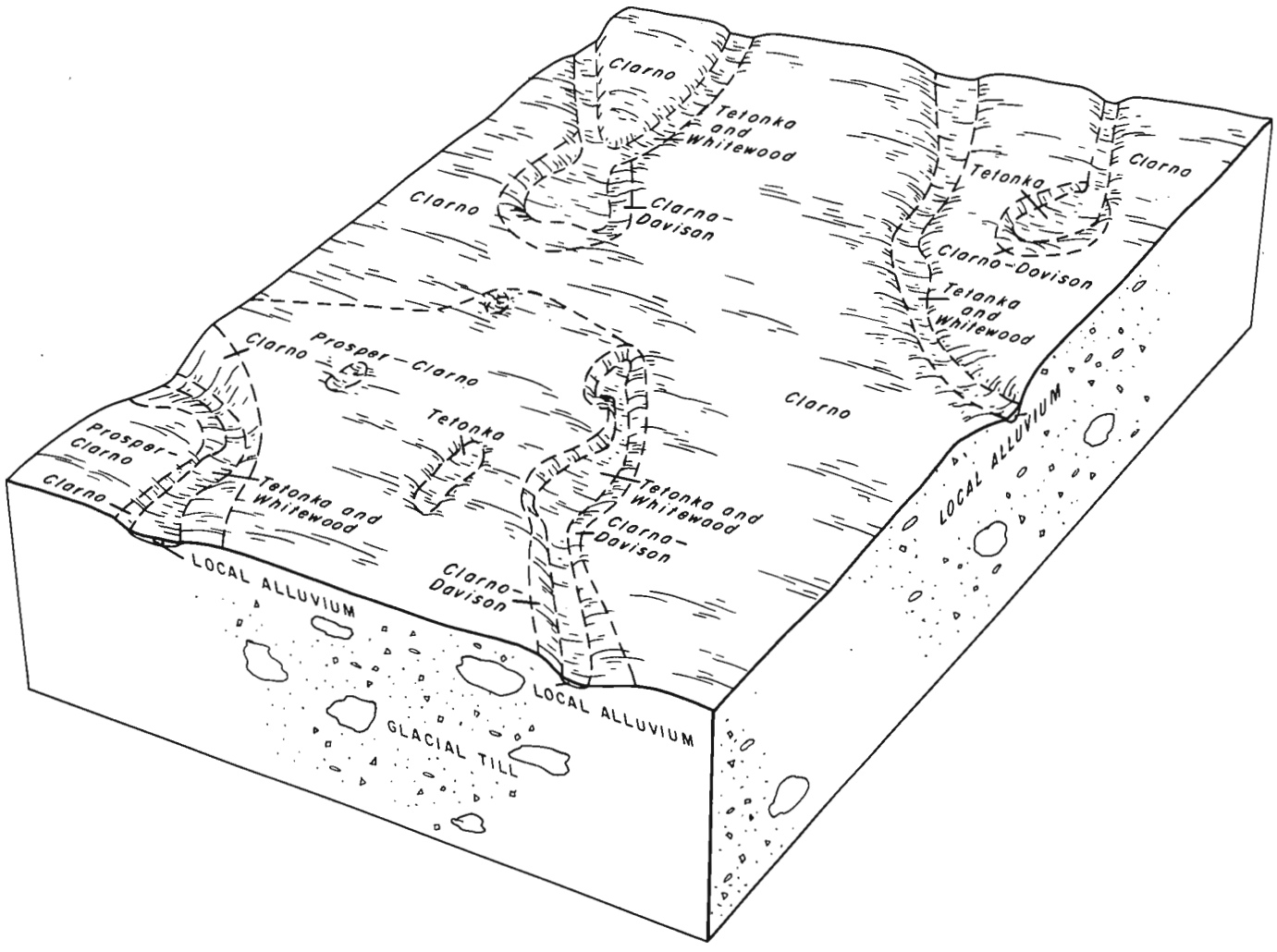

Figure 4.—Pattern of soils and geologic material in association 5.

part of the subsoil and the underlying material are light brownish gray, calcareous loam.

Minor soils in this association include Crossplain and Whitewood soils in some of the more poorly drained swales; Davison and Hand soils on some rises; and Dudley and Stickney soils on some flats.

Runoff is slow to medium on the Clarno and Prosper soils, and it ponds on the Tetonka soil. The major soils are medium to high in fertility. Clarno and Prosper soils are nearly level and have little or no limitations for crops. Farming is delayed on the Tetonka soil because of spring wetness. In some years, crops are drowned. Maintaining fertility and tilth, controlling water erosion in undulating areas of Clarno soils, and eliminating the wetness of the Tetonka soils are the main management concerns.

Most areas are cultivated. Corn, oats, soybeans, sorghum, and alfalfa are the main crops. Livestock production is the main enterprise. Much of the feed and forage crops is grown for use by beef cattle and hogs. A few dairy farms are in areas of this association.

6. *Clarno-Ethan-Tetonka association*

Well drained and poorly drained, level to rolling, loamy and silty soils that formed in glacial till and alluvium on uplands

This association consists of a glacial plain that has swells and swales with differences in elevation ranging from 10 to 50 feet. The soils are mostly nearly level to undulating, but steeper soils are on the sides of drainageways, around closed depressions, and on the sides of some ridges and knolls. The drainage pattern is moderately well defined in some places but is poorly defined in others.

This association makes up about 9 percent of the survey area. It is about 35 percent Clarno soils, 15 percent Ethan soils, and 15 percent Tetonka soils (fig. 5). Minor soils make up the rest.

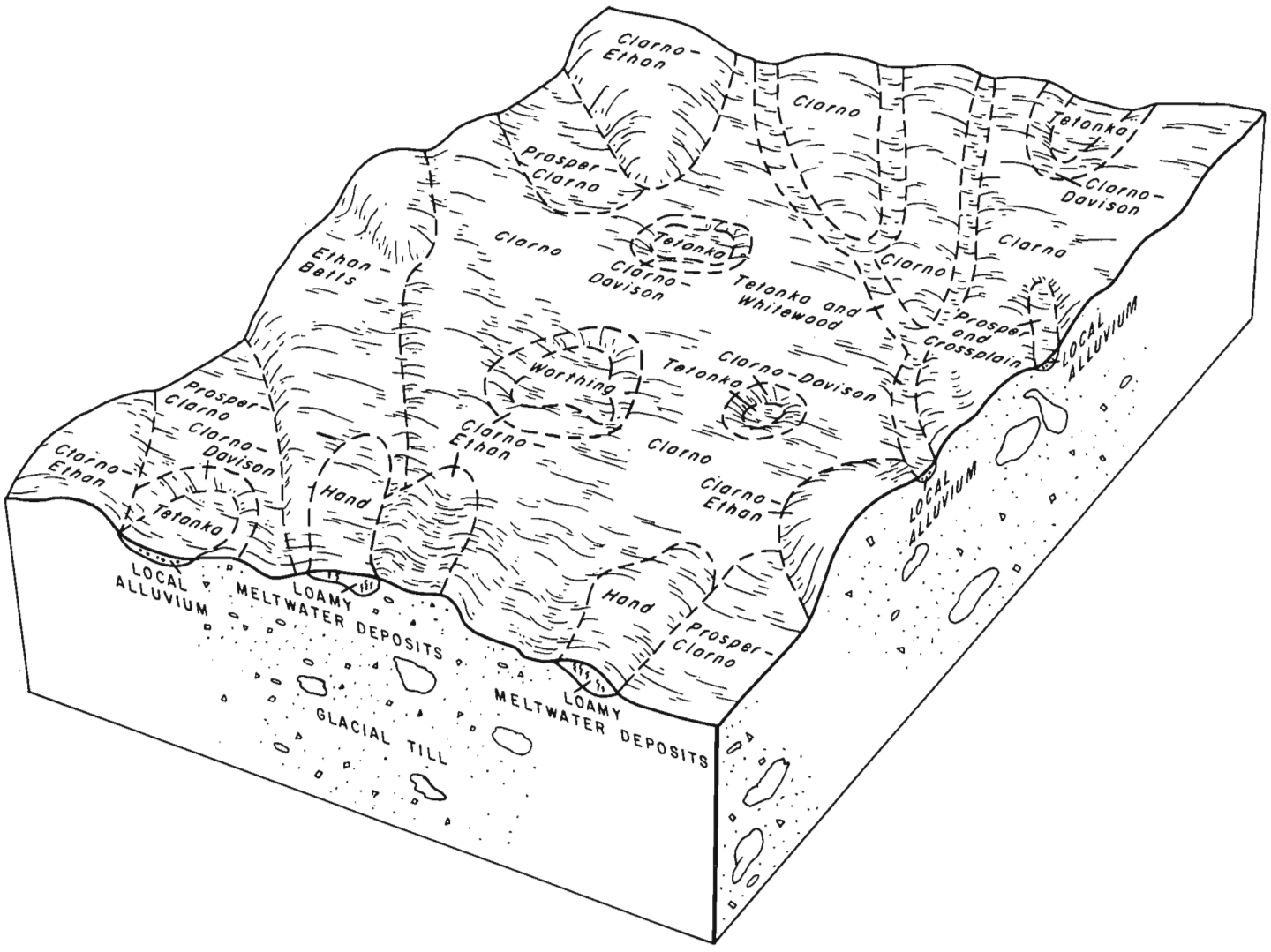

Figure 5.—**Pattern of soils and geologic material in association 6.**

Clarno soils are well drained and nearly level to gently rolling. They formed in glacial till. The surface layer is dark gray loam. The subsoil is dark grayish brown clay loam in the upper part and grayish brown loam in the middle part. The lower part of the subsoil and the underlying material are pale yellow and light yellowish brown, calcareous loam.

Ethan soils are well drained and mostly undulating to rolling. They formed in glacial till and generally are in the higher parts of the landscape on ridges and knolls. The surface layer is dark grayish brown, calcareous loam. Below this is a layer of light brownish gray, calcareous loam. The underlying material is light yellowish brown, calcareous loam.

Tetonka soils are poorly drained and level to nearly level. They formed in local alluvium and are in closed depressions or in the low parts of some drainageways. The surface layer is dark gray and gray silt loam. The subsoil is dark gray and grayish brown silty clay. The underlying material is gray and light gray calcareous clay loam and loam.

Minor soils in this association include Betts soils on the top of some ridges and knolls; Crossplain, Harps, Prosper, and Whitewood soils in swales; Davison, Hand, and Henkin soils on some rises; and Worthing soils in some depressions. Also in this association are areas of Marsh in some of the wetter depressions.

Runoff is medium in much of this association, and it ponds on the Tetonka soil. Most areas have medium fertility but some cultivated areas of Ethan soils have low fertility. Farming is delayed by wetness on Tetonka soils and on some minor soils. The hazard of erosion on Clarno and Ethan soils is the main management concern. Maintaining fertility and tilth is also a management concern.

Most areas are cultivated. Corn, oats, sorghum, soybeans, and alfalfa are the main crops. Livestock production is the main enterprise. Some of the crops are grown for marketing, but most are grown for use by beef cattle and hogs. A few dairy farms are in areas of this association.

7. *Hand-Clarno-Davison association*

Well drained and moderately well drained, nearly level to gently rolling, loamy soils that formed in glacial melt-water deposits and glacial till on uplands

This association consists of a glacial plain that is partly mantled by glacial melt-water deposits. The short, convex slopes are nearly level to gently rolling and are broken by swales, drainageways, and closed depressions.

This association makes up about 16 percent of the survey area. It is about 45 percent Hand soils, 25 percent Clarno soils, 15 percent Davison soils, and 15 percent minor soils (fig. 6).

Hand and Clarno soils are well drained and nearly level to gently rolling. Hand soils formed in glacial melt-water deposits. They have a surface layer of dark grayish brown loam. Their subsoil is grayish brown loam in the upper part and light gray, calcareous loam in the lower part. The underlying material is light yellowish brown and light gray, calcareous silt loam and loam.

Clarno soils formed in glacial till. They have a surface layer of dark gray loam. Their subsoil is dark grayish brown clay loam in the upper part and grayish brown loam in the middle part. The lower part of the subsoil and the underlying material are pale yellow and light yellowish brown, calcareous loam.

Davison soils are moderately well drained and nearly level to undulating. They are on low rises and formed in glacial melt-water deposits. They have a surface layer of grayish brown loam. The underlying material is light yellowish brown loam and silt loam to a depth of 37 inches. Below that the layers are pale yellow fine sandy loam and very fine sandy loam. The soil material is calcareous throughout.

Minor soils in this association include Betts soils on ridges and knolls; Bonilla, Crossplain, Dimo, Prosper, and Whitewood soils in swales and drainageways; Delmont, Enet, Henkin, Storla, and Talmo soils in areas of sandy or gravelly melt-water deposits; and Tetonka and Worthing soils in closed depressions.

Runoff is slow to medium, depending on the degree of slope. The major soils in this association are medium in fertility. The high content of lime in the Davison soils, however, affects crop growth and makes them susceptible to soil blowing. The nearly level Hand and Clarno soils have few or no limitations for crops. The main management concerns are controlling erosion on the undulating to gently rolling soils, controlling soil blowing, especially on the Davison soils, and maintaining fertility and tilth.

Most areas are cultivated. Corn, oats, soybeans, sorghum, and alfalfa are the main crops. Livestock production is the main enterprise. Some of the annual crops are produced for marketing, but much of the feed and forage crops are grown for use by beef cattle and hogs. A few dairy farms are in areas of this association.

8. *Crossplain-Clarno-Tetonka association*

Poorly drained and well drained, nearly level and level, loamy and silty soils that formed in glacial till and alluvium on uplands

This association is on uplands in Hutchinson County. It is characterized by mostly nearly level, broad flats that are dissected by wide swales and drainageways separated by low rises. Many small, closed depressions dot the landscape. The drainage pattern is poorly defined in much of the area.

This association makes up about 4 percent of the survey area. It is about 25 percent Crossplain soils, 25 percent Clarno soils, 15 percent Tetonka soils, and 35 percent minor soils.

Crossplain soils are poorly drained and nearly level. They are in concave swales and shallowly depressed drainageways. The surface layer is very dark gray clay loam. The subsoil is heavy clay loam that is very dark gray and dark gray in the upper part and gray in the lower part. The underlying material is gray calcareous clay loam and loam.

Clarno soils are well drained and nearly level. They formed in glacial till and are on very slight rises that are plane to slightly convex. The surface layer is dark gray loam. The subsoil is dark grayish brown clay loam in the upper part and grayish brown loam in the middle part. The lower part of the subsoil and the un-

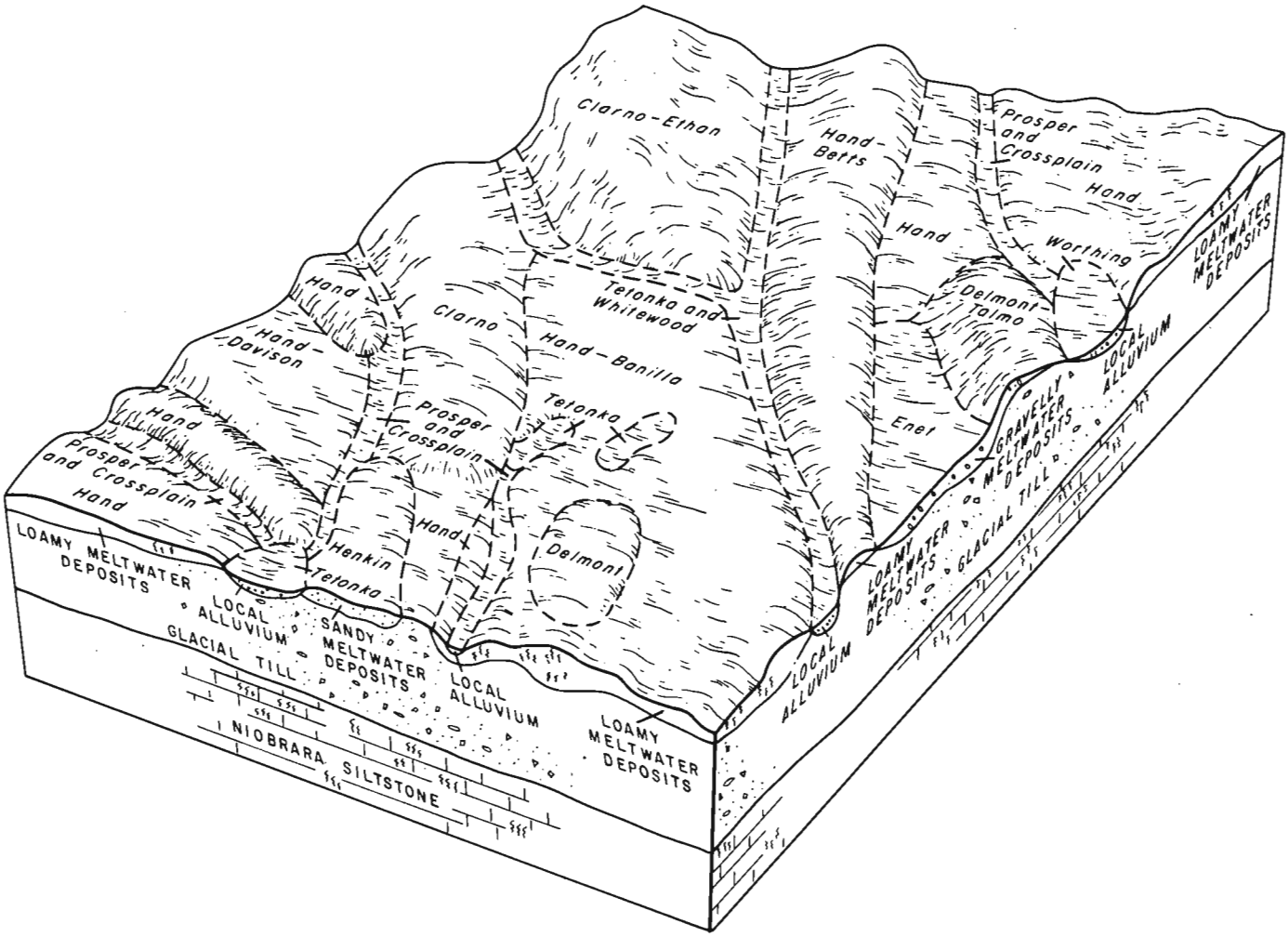

Figure 6.—**Pattern of soils and geologic material in association 7.**

derlying material are pale yellow and light yellowish brown calcareous loam.

Tetonka soils are poorly drained and level or nearly level. They formed in local alluvium and are in closed depressions or in the low parts of some drainageways or swales. The surface layer is dark gray silty clay loam. The subsurface layer is dark gray and gray silt loam. The subsoil is dark gray and grayish brown silty clay. The underlying material is gray and light gray calcareous clay loam and loam.

Minor soils in this association include Davison and Hand soils on some of the more pronounced rises; Dimo, Harps, and Prosper soils in some swales and drainageways; and Dudley and Stickney soils on flats.

Runoff is slow and ponds on the Tetonka soil. Farming is delayed by wetness from flooding or from a seasonal high water table. In wet years, crops on the Tetonka soil drown unless drainage is provided. Major soils have medium to high fertility. Maintaining fertility and tilth and reducing wetness on the Crossplain and Tetonka soils are the main concerns of management.

Most areas are cultivated, but some of the poorly drained soils are used for hay and pasture. Corn, oats, sorghum, soybeans, and alfalfa are the main crops. Livestock production is the main enterprise. Some of the annual crops are grown for marketing, but much of the feed and forage crops are grown for use by beef cattle and hogs. A few dairy farms are in areas of this association.

Description of the Soils

This section describes each soil series in detail and then, briefly, each mapping unit in that series. Unless stated otherwise, what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

The mapping units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

The descriptions together with the soil maps can be useful in determining the potential of soil and in managing it for food and fiber production; in planning land use and in developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each mapping unit, or soil, is given in the section "Use and Management of the Soils."

Soils that have profiles that are almost alike make up a *soil series.* A profile is the sequence of horizons, or layers, from the surface down to rock or other underlying material. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. Clarno and Ethan, for example, are the names of two soil series in the survey area.

The soil profile is an important part of the description of each soil series. The profile of each soil series is described twice. The first description is brief and in terms familiar to a layman. The second is more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Clarno loam, 0 to 3 percent slopes, is one of several phases within the Clarno series.

Some mapping units are made up of two or more dominant kinds of soil. Two such mapping units are shown on the soil map of this survey area: soil complexes and undifferentiated groups.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Dudley-Stickney complex, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map has at least one of the dominant (named) soils or may have all of them. Betts and Ethan loams, 15 to 40 percent slopes, is an undifferentiated group in this survey area.

Most mapping units include small, scattered areas of soils other than those that appear in the name of the mapping unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the mapping unit. These soils are described in the description of each mapping unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas;* they are delineated on the soil map and given descriptive names. Marsh is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the interpretive groups in which the mapping unit has been placed—the capability unit, pasture group, windbreak group, and range site.

The names of some soils do not agree fully with those in published surveys of adjacent counties. This is due to change in concepts of soil series in the application of the soil classification system.

The acreage and proportionate extent of each mapping unit are given in table 1, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of Tables.") Many of the terms used in describing soils are defined in the Glossary and in the Soil Survey Manual (*5*).[1]

Betts Series

The Betts series consists of deep, well drained to excessively drained, undulating to steep, loamy soils on uplands. These soils formed in glacial till. The native vegetation consisted of mid and short grasses.

In a representative profile the surface layer is dark gray loam about 5 inches thick. The subsoil, about 4 inches thick, is grayish brown loam. The underlying material is light brownish gray and light yellowish brown loam. All layers are calcareous.

Betts soils have low fertility and organic-matter content. Permeability is moderately slow below a depth of 32 inches. The available water capacity is high.

Most areas remain in native grassland and are used for grazing. Some of the less steep areas are cultivated.

Representative profile of Betts loam, in an area of Betts and Ethan loams, 15 to 40 percent slopes, in native grassland, 418 feet north and 400 feet west of the southeast corner of sec. 4, T. 102 N., R. 59 W.

A1—0 to 5 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; slight effervescence; mildly alkaline; clear smooth boundary.

B2—5 to 9 inches; grayish brown (2/5Y 5/2) loam, dark grayish brown (2/5Y 4/2) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; coatings that are very dark grayish brown (2.5Y 3/2), moist, on vertical faces of peds; strong effervescence; mildly alkaline; clear wavy boundary.

[1] Italic numbers in parentheses refer to References, p. 127.

TABLE 1.—*Acreage and proportionate extent of the soils*

Map symbol	Soil	Hanson County	Hutchinson County	Total— Area	Total— Extent
		Acres	*Acres*	*Acres*	*Pct*
BeE	Betts and Ethan loams, 15 to 40 percent slopes	11,725	22,700	34,425	4.3
Bo	Bon loam	1,405	0	1,405	0.2
Ca	Chaska soils	740	2,905	3,645	0.5
Cb	Chaska soils, channeled	2,805	10,775	13,580	1.7
Cc	Clamo silty clay loam	3,070	2,930	6,000	0.8
CdA	Clarno loam, 0 to 3 percent slopes	76,130	91,025	167,155	21.0
CdB	Clarno loam, 3 to 6 percent slopes	23,120	53,635	76,755	9.6
CeA	Clarno-Davison loams, 0 to 2 percent slopes	0	10,790	10,790	1.4
CeB	Clarno-Davison loams, 2 to 4 percent slopes	15,470	12,300	27,770	3.5
CnC	Clarno-Ethan loams, 6 to 9 percent slopes	6,275	12,315	18,590	2.3
CsA	Clarno-Stickney loams, 0 to 2 percent slopes	0	4,900	4,900	0.6
Ct	Crossplain-Harps complex	0	3,390	3,390	0.4
DaB	Davis loam, 2 to 6 percent slopes	1,510	3,860	5,370	0.7
DaC	Davis loam, 6 to 9 percent slopes	270	0	270	(1)
DbA	Davison soils, 0 to 3 percent slopes	900	2,405	3,305	0.4
DcB	Davison-Onita complex, 2 to 6 percent slopes	0	1,325	1,325	0.2
DeA	Delmont loam, 0 to 3 percent slopes	195	3,795	3,990	0.5
DeB	Delmont loam, 3 to 6 percent slopes	1,990	2,250	4,240	0.5
DmB	Delmont-Rock outcrop complex, 2 to 9 percent slopes	430	0	430	0.1
DnD	Delmont-Talmo complex, 6 to 12 percent slopes	590	915	1,505	0.2
Do	Dimo loam	770	1,605	2,375	0.3
DsA	Dudley-Stickney complex, 0 to 2 percent slopes	8,820	10,840	19,660	2.5
Du	Durrstein silt loam	600	1,205	1,805	0.2
EaC	Egan silt loam, 6 to 9 percent slopes	0	835	835	0.1
EbC2	Egan-Betts complex, 3 to 9 percent slopes, eroded	0	1,280	1,280	0.2
EgB	Egan and Wentworth silt loams, 2 to 6 percent slopes	0	4,440	4,440	0.6
EnA	Enet loam, 0 to 2 percent slopes	2,740	0	2,740	0.3
EtB	Ethan-Betts loams, 3 to 6 percent slopes	0	5,090	5,090	0.6
EtC2	Ethan-Betts loams, 6 to 9 percent slopes, eroded	0	8,305	8,305	1.0
EtD	Ethan-Betts loams, 9 to 15 percent slopes	3,560	8,675	12,235	1.5
EuB	Ethan-Clarno loams, 2 to 6 percent slopes	730	0	730	0.1
EuC	Ethan-Clarno loams, 6 to 9 percent slopes	3,440	0	3,440	0.4
EwC	Ethan-Homme complex, 6 to 9 percent slopes	0	1,210	1,210	0.2
Fa	Fedora soils	0	655	655	0.1
HaA	Hand loam, 0 to 3 percent slopes	12,425	13,710	26,135	3.3
HaB	Hand loam, 3 to 6 percent slopes	5,885	14,000	19,885	2.5
HaC	Hand loam, 6 to 9 percent slopes	2,255	2,725	4,980	0.6
HbC	Hand-Betts loams, 6 to 9 percent slopes	0	1,335	1,335	0.2
HcA	Hand-Bonilla loams, 0 to 3 percent slopes	0	1,485	1,485	0.2
HdB	Hand-Davison loams, 3 to 6 percent slopes	3,740	6,660	10,400	1.3
HmA	Henkin fine sandy loam, 0 to 2 percent slopes	1,065	0	1,065	0.1
HmB	Henkin fine sandy loam, 2 to 6 percent slopes	2,270	4,010	6,280	0.8
HnB	Henkin variant fine sandy loam, 0 to 6 percent slopes	210	1,700	1,910	0.2
HoC	Homme-Ethan complex, 6 to 9 percent slopes	0	2,150	2,150	0.3
HtA	Homme-Onita complex, 0 to 2 percent slopes	0	3,200	3,200	0.4
HtB	Homme-Onita complex, 2 to 6 percent slopes	0	5,950	5,950	0.7
Ja	James silty clay	870	870	1,740	0.2
La	Lamo silty clay loam	395	2,160	2,555	0.3
Lm	Lamo-Wann complex, frequently flooded	1,050	605	1,655	0.2
Ma	Marsh	2,580	1,695	4,275	0.5
OaA	Onita silt loam, 0 to 3 percent slopes	0	820	820	0.1
PcA	Prosper-Clarno loams, 0 to 2 percent slopes	11,930	66,425	78,355	9.8
Pr	Prosper-Stickney complex	29,600	33,185	62,785	7.9
Ps	Prosper and Crossplain soils	0	13,565	13,565	1.7
ReB	Redstoe silt loam, 0 to 6 percent slopes	760	0	760	0.1
Sa	Salmo silty clay loam	1,250	2,035	3,285	0.4
St	Storla variant loam	0	635	635	0.1
Te	Tetonka silty clay loam	21,790	27,875	49,665	6.2
Tt	Tetonka-Harps complex	1,740	6,900	8,640	1.1
Tw	Tetonka and Whitewood silty clay loams	3,845	14,000	17,845	2.2
Wa	Wann loam	0	795	795	0.1
Ww	Worthing silty clay loam	3,385	4,470	7,855	1.0
	Water areas	1,170	1,855	3,025	0.4
	Gravel pits and quarries	340	430	770	0.1
	Total	275,840	521,600	797,440	100.0

[1] Less than 0.1 percent.

C1ca—9 to 14 inches; light brownish gray (2/5Y 6/2) loam, olive brown (2/5Y 4/3) moist; weak coarse subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common medium segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C2ca—14 to 32 inches; light yellowish brown (2/5Y 6/3) loam, olive brown (2/5Y 4/3) moist; few fine and medium distinct mottles of olive yellow (2/5Y 6/6) moist; massive; hard, friable, slightly sticky and slightly plastic; common medium segregations of lime; strong effervescence; mildly alkaline; diffuse boundary.

C3—32 to 60 inches; light yellowish brown (2/5Y 6/3) loam, olive brown (2.5Y 4/4) moist; many medium distinct mottles of olive yellow (5Y 6/6) and yellowish brown (10YR 5/6) moist; massive; hard, friable, slightly sticky and slightly plastic; few medium segregations of lime; strong effervescence; mildly alkaline.

The solum is less than 10 inches thick. Free carbonates are at or within 3 inches of the surface. Reaction throughout the profile is mildly alkaline or moderately alkaline. A few pebbles, cobbles, or stones are scattered throughout some profiles. The A horizon is very dark gray to grayish brown, but the Ap horizon is light brownish gray in some cultivated areas. It is 3 to 5 inches thick. The B2 horizon ranges from grayish brown to light yellowish brown. The C horizon is grayish brown to pale olive in hue of 2.5Y or 5Y and is loam or clay loam. Mottles in the C horizon are relict from glacial till. Segregations of lime are common or many in the Cca horizon. In places, nests of gypsum crystals are in the lower part of the C horizon.

Betts soils are mapped with Egan, Ethan, and Hand soils and are near Talmo soils. They have a thinner A horizon than Egan, Ethan, and Hand soils; and they are less gravelly and contain more clay in the C horizon than Talmo soils.

BeE—Betts and Ethan loams, 15 to 40 percent slopes. These soils are on hills and ridges. Areas range from 5 to 200 acres in size. Slopes are mostly short and convex. Some of the mapped areas are mostly Betts soil, others are mostly Ethan soil, and some are made up of both soils in varying proportions. Betts soil generally is on the upper side slopes and crests of ridges and knolls. Ethan soil is on the side of ridges and knolls and generally is less steep than Betts soil. The Betts soil has the profile described as representative of the series. The Ethan soil commonly has a noncalcareous surface layer. Small stony areas, 1 to 5 acres in size, are in some of the mapped areas.

Included with these soils in mapping are small areas of Clarno, Davis, Delmont, Hand, Henkin, and Talmo soils. Clarno, Davis, Hand, and Henkin soils are mainly in the lower part of the landscape where slopes are more gentle. The Delmont and Talmo soils are on some of the well-rounded tops of ridges and knolls.

Runoff is medium to rapid. The hazard of erosion is very severe if the plant cover is removed. Controlling erosion is the main concern of management.

Almost all areas remain in native grassland and are used for grazing. These soils are unsuited to cultivation because of the hilly to steep slopes and the very severe erosion hazard. Windbreak group 10; Betts soil is in capability unit VIIe–1, not placed in a pasture group; Ethan soil is in capability unit VIe–3, pasture group G.

Bon Series

The Bon series consists of deep, moderately well drained, nearly level, loamy soils on bottom lands. These soils formed in alluvium. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer, about 22 inches thick, is very dark gray loam in the upper part and gray calcareous loam in the lower part. The next layer, to a depth of 40 inches, is dark gray calcareous silt loam and loam. The underlying material, to a depth of 55 inches, is gray calcareous loam. Grayish brown calcareous sandy loam is at a depth of 55 inches.

Bon soils have high fertility and organic-matter content. Permeability is moderate, and the available water capacity is moderate or high. Most areas are subject to flooding.

Some areas are cultivated, but many narrow areas along stream channels remain in native grassland and are used for hay and for grazing.

Representative profile of Bon loam, in native grassland, 235 feet south and 130 feet east of the northwest corner of sec. 3, T. 103 N., R. 59 W.

A11—0 to 3 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

A12—3 to 12 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, very friable, slightly sticky and slightly plastic; neutral; abrupt wavy boundary.

A13—12 to 22 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; hard, very friable, slightly sticky and slightly plastic; common fine segregations of lime; strong effervescence; mildly alkaline; abrupt wavy boundary.

A11b—22 to 32 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few fine streaks of gypsum; few fine segregations of lime; violent effervescence; moderately alkaline; clear wavy boundary.

A12b—32 to 40 inches; dark gray (10YR 4/1)

loam, very dark gray (10YR 3/1) moist; weak medium and coarse subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; common fine segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—40 to 55 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; many fine segregations of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C2—55 to 60 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable; strong effervescence; mildly alkaline.

Free carbonates are at or within 16 inches of the surface. The A horizon is very dark gray to grayish brown in hue of 10YR or 2.5Y. It commonly is loam but ranges from very fine sandy loam to silt loam. It is 20 to 40 inches thick. Some profiles lack a buried A horizon, and some have an AC horizon. The C horizon is gray to light yellowish brown in hue of 10YR or 2.5Y. It commonly is stratified with finer and coarser textures ranging from loamy sand to silty clay loam.

Bon soils are better drained than Chaska, Clamo, James, Lamo, and Salmo soils which also are on bottom lands. In addition, Bon soils contain less clay than Clamo and James soils and are less silty than Lamo and Salmo soils.

Bo—Bon loam. This soil is nearly level and is on bottom lands along small streams in Hanson County. Areas are long and narrow and range from 5 to 40 acres in size. Slopes are 0 to 2 percent. In places this soil has a surface layer of very fine sandy loam or silt loam.

Included with this soil in mapping are small areas of Chaska and Davis soils. The Chaska soil is in the lower part of the landscape near the stream channel, and the Davis soil is on foot slopes on the edge of the mapped areas.

Runoff is slow. Most areas are subject to flooding from stream overflow or from runoff received from adjacent uplands. In most years, however, the additional moisture is beneficial. This soil has few or no limitations for use as cropland. Maintaining fertility is the main concern of management.

This soil is well suited to all crops commonly grown in the survey area. Most of the larger areas are used for crops; some narrow areas remain in native grassland and are used for hay and pasture. Capability unit I–1, pasture group K, windbreak group 1.

Bonilla Series

The Bonilla series consists of deep, moderately well drained, nearly level, loamy soils on uplands, in swales, and on foot slopes. These soils formed in alluvium that washed from adjacent soils and in stratified glacial drift or glacial melt-water deposits. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is dark gray loam about 9 inches thick. The subsoil, about 28 inches thick, is loam that is dark gray in the upper part, grayish brown in the middle part, and light brownish gray and light gray in the lower part. The lower part is calcareous. The underlying material is light yellowish brown, calcareous silt loam, fine sandy loam, and light clay loam.

Bonilla soils have high fertility and organic-matter content. Permeability is moderate in the subsoil and moderate to moderately slow in the underlying material. The available water capacity is high. These soils are subject to flooding for short periods, and they have a seasonal high water table at a depth of 4 to 6 feet.

Most areas are cultivated, but some remain in native grassland and are used for grazing and hay.

Bonilla soils in this survey area are mapped only with Hand soils.

Representative profile of Bonilla loam, in an area of Hand-Bonilla loams, 0 to 3 percent slopes, in cultivation, 883 feet west and 860 feet north of the southeast corner of sec. 20, T. 98 N., R. 57 W.

Ap—0 to 9 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; hard, very friable, slightly sticky; slightly acid; clear wavy boundary.

B21—9 to 18 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak coarse and medium prismatic structure parting to weak medium and coarse subangular blocky; hard, very friable, slightly sticky; slightly acid; clear wavy boundary.

B22—18 to 24 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak and moderate medium subangular blocky; hard, friable, slightly sticky; slightly acid; clear wavy boundary.

B31ca—24 to 30 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; very hard, friable, slightly sticky; few medium segregations of lime; strong effervescence; moderately alkaline; gradual irregular boundary.

B32ca—30 to 37 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; weak coarse subangular blocky structure; very hard, friable, slightly sticky; many medium segregations of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C1ca—37 to 47 inches; light yellowish brown (2.5Y 6/3) silt loam, olive brown (2.5Y 4/3) moist; weak coarse subangular blocky structure; hard, friable, slightly sticky; many medium segregations of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C2—47 to 56 inches; light yellowish brown (2.5Y 6/3) fine sandy loam, olive brown (2.5Y 4/3) moist; massive; slightly hard, very

friable, slightly sticky; few fine and medium segregations of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C3—56 to 60 inches; light yellowish brown (2.5Y 6/3) and gray (2.5Y 6/1) light clay loam, olive brown (2.5Y 4/4) and dark gray (2.5Y 4/1) moist; few medium and fine distinct mottles of olive yellow (2.5Y 6/6) and yellowish brown (10YR 5/6) moist; massive; hard, friable, slightly sticky; strong effervescence; moderately alkaline.

Depth to free carbonates is 21 to 33 inches. The A horizon is very dark gray to dark grayish brown. It commonly is loam, but in places it is silt loam or light clay loam. It is 8 to 10 inches thick and is slightly acid or neutral. The B2 horizon has hue of 10YR or 2.5Y and is loam or light clay loam. It is 13 to 23 inches thick and is slightly acid to mildly alkaline. The B3 and C horizons are gray to pale olive in hue of 2.5Y or 5Y. Texture is stratified, and some profiles contain 1- to 10-inch lenses of silty clay loam or loamy sand. The lower part of the C horizon in some pedons has nests of gypsum crystals.

Bonilla soils are mapped with Hand soils and are near Crossplain, Davison, and Tetonka soils. They are better drained and have a less clayey B horizon than Crossplain and Tetonka soils. Bonilla soils are deeper than Davison soils and have dark colors, when moist, at a greater depth than Hand soils.

Chaska Series

The Chaska series consists of deep, somewhat poorly drained to poorly drained, nearly level, silty and loamy soils on bottom land. These soils formed in alluvium. The native vegetation consisted of tall grasses, sedges, and deciduous trees and shrubs.

In a representative profile the surface layer is about 28 inches thick. The upper 8 inches is very dark gray silt loam, and the rest is very dark gray calcareous loam. The underlying material, to a depth of 47 inches, is dark gray calcareous fine sandy loam. Gray and grayish brown calcareous loamy fine sand is at a depth of 47 inches.

Chaska soils have high fertility and organic-matter content. Permeability is moderate to a depth of 28 inches and moderately rapid in the underlying material. The available water capacity is moderate or high. These soils are subject to stream flooding. Early in the growing season they have a seasonal water table at a depth of 1 to 3 feet.

Some of the larger areas are cultivated, but many areas remain in native vegetation and are used for hay crops and for grazing.

Representative profile of Chaska silt loam, in an area of Chaska soils, in cultivation, 500 feet south and 255 feet east of the northwest corner of sec. 3, T. 99 N., R. 57 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; neutral; abrupt wavy boundary.

A12—8 to 20 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; bleached sand grains on vertical faces of peds; slight effervescence; mildly alkaline; abrupt wavy boundary.

A13g—20 to 28 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; common fine distinct mottles of olive yellow (2.5Y 6/6) moist; weak medium and coarse subangular blocky structure; slightly hard, very friable; strong effervescence; mildly alkaline; clear wavy boundary.

C1g—28 to 47 inches; dark gray (10YR 4/1) fine sandy loam, very dark brown (10YR 2/2) moist; common fine distinct mottles of olive yellow (2.5Y 6/6) moist; massive; soft, very friable; strong effervescence; mildly alkaline; clear wavy boundary.

C2g—47 to 60 inches; gray (10YR 5/1) and grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; many fine distinct mottles of olive yellow (2.5Y 6/6) moist; single grained; loose; strong effervescence; mildly alkaline.

Depth to free carbonates is less than 10 inches. Reaction below a depth of 10 inches is mildly alkaline or moderately alkaline. The A horizon is very dark gray to dark grayish brown in hue of 10YR or 2.5Y. It commonly is loam or silt loam, but in places is very fine sandy loam. It is 20 to 40 inches thick. Some profiles have an AC horizon. The C horizon is dark gray to pale yellow in hue of 10YR, 2.5Y, or 5Y. It commonly is stratified with a finer or coarser texture ranging from gravelly sand to silty clay loam.

Chaska soils in this survey area are not so wet as is defined in the range for the series and they contain more sand in the C horizon, but these differences do not significantly alter their use or behavior.

Chaska soils are near Clamo, Lamo, and Wann soils. They are less clayey than the Clamo soils and are more poorly drained than the Lamo and Wann soils. Chaska soils also have more sand and less silt than the Lamo soils and contain more clay than the Wann soils.

Ca—Chaska soils. These soils are nearly level and are on bottom land. Areas are irregular in shape and range from 5 to 75 acres in size. Slopes are 0 to 2 percent. The surface layer is silt loam, loam, or very fine sandy loam, and in some mapped areas all of these textures are present. A profile of a Chaska silt loam is described as representative of the series.

Included with these soils in mapping are small areas of Bon, Davis, and Salmo soils. Bon soils are on slightly higher levels of the landscape. Davis soils are on foot slopes and fans on the edge of the mapped areas. Salmo soils are in some of the low areas with Chaska soil.

Runoff is slow. Farming is delayed in some years by

wetness caused by flooding and a high water table. In other years drainage is adequate for crops. Wetness is the main concern of management.

Many of the larger areas are cultivated. The soils are better suited to late-seeded row crops than to spring-sown small grain. Alfalfa and tame grass are important crops. Areas in native vegetation are used for grazing and for wildlife. Capability unit IIw–3, pasture group A, windbreak group 2.

Cb—Chaska soils, channeled. These soils are nearly level and are on bottom lands. Slopes are 0 to 2 percent. Areas are long and narrow and range from 5 to 20 acres in size. They are dissected by stream channels and meander scars. The surface layer is silt loam, loam, or very fine sandy loam. Sandy to loamy overwash of recent alluvium is on the surface in some low areas adjacent to the channels. These soils have mottled colors nearer the surface than is described as representative of the series.

Included with these soils in mapping are small areas of Bon, Davis, Lamo, Salmo, and Wann soils. Bon and Davis soils are on some of the higher levels of the flood plain. Lamo and Wann soils are intermingled with Chaska soils. Salmo soils are in some of the meander scars.

Runoff is slow. These soils are subject to frequent flooding, and they have a water table that is near the surface early in the growing season. The meandering stream channels that dissect the areas make farming impractical.

Most areas remain in native vegetation and are used for grazing and wildlife, but a few areas are cultivated. Alfalfa and tame grasses are the main crops. Capability unit VIw–1, pasture group A, windbreak group 10.

Clamo Series

The Clamo series consists of deep, poorly drained, nearly level, silty soils on bottom lands. These soils formed in alluvium and have a clayey subsoil. The native vegetation consisted mainly of tall grasses and deciduous trees and shrubs.

In a representative profile the surface layer is about 11 inches thick. The upper part is very dark gray silty clay loam, and the lower part is dark gray silty clay. The subsoil, about 20 inches thick, is silty clay that is dark gray in the upper part and gray in the lower part. The lower part of the subsoil is calcareous. The underlying material is dark gray and gray silty clay and contains nests of gypsum crystals.

Clamo soils have high fertility and organic-matter content. Permeability is slow, and the available water capacity is moderate or high. These soils are subject to stream flooding. Early in the growing season a seasonal high water table is at a depth of 2 to 3 feet.

Many areas are cultivated. Some remain in native vegetation and are used for hay crops and for grazing.

Representative profile of Clamo silty clay loam, in native grassland, 1,845 feet west and 450 feet north of the southeast corner of sec. 22, T. 99 N., R. 58 W.

A11—0 to 5 inches; very dark gray (2.5Y 3/1) silty clay loam, black (2.5Y 2/1) moist; weak fine granular structure; hard, friable, sticky and plastic; neutral; clear wavy boundary.

A12—5 to 11 inches; dark gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) moist; weak medium and fine subangular blocky structure; hard, firm, sticky and plastic; mildly alkaline; clear wavy boundary.

B2g—11 to 15 inches; dark gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; hard, firm, sticky and plastic; mildly alkaline; clear wavy boundary.

B31gca—15 to 25 inches; gray (2.5Y 5/1) silty clay, very dark gray (2.5Y 3/1) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; many medium and fine segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

B32gca—25 to 31 inches; gray (5Y 5/1) silty clay, very dark gray (5Y 3/1) moist; weak coarse prismatic structure parting to moderate medium and fine subangular blocky and blocky; very hard, very firm, sticky and plastic; many coarse and medium segregations of lime; violent effervescence; mildly alkaline; clear wavy boundary.

C1gcs—31 to 38 inches; dark gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; many fine and medium nests of gypsum crystals; common medium segregations of lime; slight effervescence; moderately alkaline; clear wavy boundary.

C2gcs—38 to 54 inches; dark gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; very hard, very firm, sticky and plastic; many medium and coarse nests of gypsum crystals; mildly alkaline; gradual wavy boundary.

C3gcs—54 to 60 inches; dark gray (5Y 4/1) and gray (5Y 5/1) silty clay, very dark gray (5Y 3/1) moist; massive; very hard, very firm, sticky and plastic; common medium and coarse nests of gypsum crystals; mildly alkaline.

The solum is 24 to 36 inches thick. Depth to free carbonates is 14 to 19 inches. The A horizon has hue of 10YR or 2.5Y and is 8 to 12 inches thick. The B2 horizon has hue of 2.5Y or 5Y and is 4 to 7 inches thick. The B3 horizon is dark gray or gray in hue of 2.5Y or 5Y and in places is silty clay loam. The C horizon is dark gray to light gray in hue of 2.5Y or 5Y. It is silty clay or silty clay loam and in places is stratified with lenses of silt loam to loamy sand. Some profiles do not have nests of gypsum crystals in the lower part of the C horizon. In places a buried A horizon is in the C horizon.

Clamo soils are near Chaska, James, Lamo, Salmo, and Wann soils. They are more clayey below the A horizon than Chaska, Lamo, and Wann soils and contain less salt than the James and Salmo soils.

Cc—Clamo silty clay loam. This soil is nearly level and is on bottom lands mainly along the James River. Areas are irregular in shape and range from 10 to 150 acres in size. Slopes are 0 to 2 percent. In places the surface layer is silty clay, and in places the lower part of the underlying material is stratified with thin layers of silty to sandy material.

Included with this soil in mapping are small areas of Chaska, Davis, Lamo, and Wann soils. Chaska and Wann soils are in the lower part of the landscape near the river channel. Davis soils are on foot slopes and fans on the edge of the stream valley, James soils are in old channels, or meander scars, and Lamo soils are on slight rises.

Runoff is slow. Farming is delayed in some years by wetness resulting from flooding and from a high water table. In other years drainage is adequate for crops. This soil compacts and loses its tilth if farmed when wet. Wetness and maintaining tilth are the main concerns of management.

Many areas are cultivated. Corn, sorghum, and alfalfa are the main crops. Capability unit IIw–3, pasture group A, windbreak group 2.

Clarno Series

The Clarno series consists of deep, well drained, nearly level to gently rolling, loamy soils on uplands. These soils formed in glacial till. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark gray loam about 9 inches thick. The subsoil, about 27 inches thick, is dark grayish brown clay loam in the upper part, grayish brown loam in the middle part, and pale yellow calcareous loam in the lower part. The underlying material is pale yellow and light yellowish brown, calcareous loam.

Clarno soils are medium in fertility and moderate in organic-matter content. Permeability is moderate in the subsoil and moderately slow in the underlying material. The available water capacity is high.

Most areas are cultivated. A few areas remain in native grass and are used for grazing and for hay.

Representative profile of Clarno loam, 0 to 3 percent slopes, in cultivation, 1,850 feet east and 105 feet south of the northwest corner of sec. 17, T. 97 N., R. 57 W.

Ap—0 to 9 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to weak fine granular; slightly hard, very friable; neutral; abrupt smooth boundary.

B21—9 to 12 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; weak coarse and medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; mildly alkaline; clear wavy boundary.

B22—12 to 16 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; mildly alkaline; clear wavy boundary.

B31ca—16 to 24 inches; pale yellow (2.5Y 7/3) loam, light olive brown (2.5Y 5/3) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few medium segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

B32ca—24 to 36 inches; pale yellow (2.5Y 7/3) loam, light olive brown (2.5Y 5/3) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common medium segregations of lime; strong effervescence; mildly alkaline; clear irregular boundary.

C1cs—36 to 48 inches; pale yellow (2.5Y 7/3) loam, light olive brown (2.5Y 5/3) moist; massive; hard, friable, slightly sticky and slightly plastic; few fragments of shale; many medium nests of gypsum crystals; few medium segregations of lime; strong effervescence; mildly alkaline; diffuse boundary.

C2cs—48 to 60 inches; light yellowish brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) moist; many medium distinct mottles of gray (2.5Y 6/1), olive yellow (2.5Y 6/6), and yellowish brown (10YR 5/6) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine very dark brown (10YR 2/2) moist segregations of iron and manganese oxides; common coarse nests of gypsum crystals; few medium segregations of lime; strong effervescence; mildly alkaline.

The solum is 20 to 36 inches thick. Depth to free carbonates is 12 to 24 inches. The A horizon is very dark gray to grayish brown. It is neutral or slightly acid and is 6 to 10 inches thick. The B2 horizon is neutral or mildly alkaline and is 6 to 10 inches thick. The B3 and C horizons range from grayish brown to pale yellow. In some profiles these horizons are clay loam. Mottles in the C horizon are relict from the glacial till. In some places the C horizon has no nests of gypsum crystals; in others it has many. The C horizon is mildly alkaline to strongly alkaline.

Clarno soils are mapped with Davison, Ethan, and Prosper soils and are similar to Hand soils. Clarno soils contain fewer carbonates and are better drained than Davison soils, are deeper to free carbonates than Ethan soils, have more uniform texture in the C horizon than Hand soils, and have a thinner A horizon and are better drained than Prosper soils.

CdA—Clarno loam, 0 to 3 percent slopes. This is a nearly level and gently undulating soil on broad upland

plains. Areas are irregular in shape and range from 5 to 300 acres in size. They consist of very slight rises separated by narrow swales and closed depressions. This soil has the profile described as representative of the series, except that in some places the surface layer is light clay loam.

Included with this soil in mapping are small areas of Crossplain, Davison, Dudley, Prosper, Stickney, and Tetonka soils. Crossplain and Prosper soils are in narrow swales, and Davison soils are on the lower part of some rises. Dudley and Stickney soils are on small flats or in slight depressions. Tetonka soils are in closed depressions, some of which are shown on the map by the symbol for a wet spot.

Runoff is slow to medium, and the hazard of erosion is slight. This soil has few or no limitations for use as cropland. Maintaining fertility and tilth is the main concern of management.

This soil is well suited to all crops commonly grown in the survey area. Most areas are cultivated. Capability unit I–2, pasture group F, windbreak group 3.

CdB—Clarno loam, 3 to 6 percent slopes. This is an undulating soil on uplands. Mapped areas are irregular in shape and are 5 to 150 acres in size. They consist of low knolls and ridges separated by narrow swales and small closed depressions. Slopes are plane to convex. In a few places the underlying material is stratified with thin layers of fine sandy loam and silt loam.

Included with this soil in mapping are small areas of Davison, Ethan, Prosper, Tetonka, and Whitewood soils. Davison soils are on slight rises near swales and depressions. Ethan soils are on the crest of some ridges and knolls and are moderately eroded in places. Tetonka soils are in closed depressions, some of which are shown on the soil map by the symbol for a wet spot.

Runoff is medium, and the hazard of erosion is moderate. Controlling erosion is the main concern of management.

This soil is well suited to all crops commonly grown in the survey area. Most areas are cultivated. Capability unit IIe–2, pasture group F, windbreak group 3.

CeA—Clarno-Davison loam, 0 to 2 percent slopes. These soils are nearly level and are on uplands in Hutchinson County. Areas are irregularly shaped and range from 5 to 60 acres. These areas are about 55 percent Clarno soil, 30 percent Davison soil, and 15 percent other soils. The Clarno soil is on very slight rises. The Davison soil is in areas that border narrow swales and small depressions. In places the underlying material of the Clarno soil is stratified. In most places Davison soil has underlying material that is less stratified than is described as representative of the series.

Included with these soils in mapping are small areas of Crossplain, Harps, Prosper, and Tetonka soils. Crossplain and Prosper soils are in narrow swales. Harps soils are adjacent to some swales and depressions and are below the Davison soil. Tetonka soils are in small closed depressions, some of which are shown on the map by the symbol for a wet spot.

Runoff is slow. Wetness from the high water table delays farming on the Davison soil in some years. The Clarno soil has few or no limitations to use for crops. The high content of lime in the Davison soil affects fertility and causes the soil to blow easily. Control of soil blowing on the Davison soil is the main concern of management.

Most areas are used as cropland. The soils are well suited to all crops commonly grown in the survey area. Pasture group F; Clarno soil is in capability unit I–2, windbreak group 3; Davison soil is in capability unit IIe–4, windbreak group 1.

CeB—Clarno-Davison loams, 2 to 4 percent slopes. These soils are gently undulating and are on uplands on slight rises interspersed with swales and small closed depressions. The slopes are convex and in places range to 6 percent. Areas are irregular in shape and range from 5 to 75 acres.

This complex is about 60 percent Clarno soil, 25 percent Davison soil, and 15 percent other soils. The two major soils occur in an erratic pattern and are so intricately mixed that it was not practical to separate them in mapping. In a few places the underlying material in the Clarno soil is stratified with thin layers of fine sandy loam and silt loam.

Included with these soils in mapping are small areas of Crossplain, Harps, Prosper, Tetonka, and Whitewood soils. The Crossplain, Prosper, and Whitewood soils are in swales. Harps soils are on the edge of some of the more deeply entrenched swales. Tetonka soils are in closed depressions, some of which are shown on the map by the symbol for a wet spot.

Runoff is medium. These soils are subject to erosion. The high content of lime in the Davison soil affects its fertility and causes the soil to blow easily. Controlling erosion and soil blowing is the main concern of management.

Most areas are cultivated. These soils are well suited to all crops commonly grown in the survey area. Pasture group F; Clarno soil is in capability unit IIe–2, windbreak group 3; Davison soil is in capability unit IIIe–8, windbreak group 1.

CnC—Clarno-Ethan loams, 6 to 9 percent slopes. These soils are gently rolling. The areas are irregular in shape and range from 5 to 60 acres in size.

The areas are about 60 percent Clarno soil, 25 percent Ethan soil, and 15 percent other soils. Slopes are mostly short and convex. The Clarno soil is in the mid and lower parts of the landscape, and the Ethan soil is on the upper side slopes and tops of ridges and knolls. The Clarno soil has a thinner surface layer and a thinner subsoil than those described as representative of the series. In a few places the underlying material in the Clarno soil is stratified with thin layers of fine sandy loam and silt loam.

Included with these soils in mapping are small areas of Betts, Bonilla, Prosper, and Tetonka soils. Betts soils are on the tops of some ridges and knolls and are moderately eroded where cultivated. Bonilla and Prosper soils are in narrow swales and drainageways. Tetonka soils are in closed depressions, some of which are shown on the map by the symbol for a wet spot.

Runoff is medium, and the hazard of erosion is severe. Controlling erosion is the main concern of management.

Most areas are cultivated. These soils are suited to most crops grown in the survey area if erosion is controlled. Clarno soil is in capability unit IIIe–1, pasture group F, windbreak group 3; Ethan soil is in

capability unit IVe–2, pasture group G, windbreak group 8.

CsA—Clarno-Stickney loams, 0 to 2 percent slopes. These soils are on upland flats in south-central Hutchinson County. Areas range from 25 to 50 acres. They are about 60 percent Clarno soil, 20 percent Stickney soil, and 20 percent other soils. The Clarno soil is on very slight rises. The Stickney soil is in circular areas on flats or on the slightly depressed tops of rises. The Stickney soil has a surface layer of loam; otherwise the profile is similar to the one described as representative of the series.

Included with these soils in mapping are small areas of Crossplain, Davison, Prosper, and Tetonka soils. Crossplain and Prosper soils are in swales or slightly depressed drainageways. Davison soils are on rises in some places. Tetonka soils are in closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is slow to medium, and the hazard of erosion is slight. The Clarno soil has few or no limitations to use for crops, but the Stickney soil has a claypan subsoil that takes in water slowly and restricts root growth. Improving the water intake of the Stickney soil is the main concern of management.

Many areas are cultivated. These soils are well suited to all crops commonly grown in the survey area. The claypan subsoil in the Stickney soil, however, restricts crop growth during periods of drought. Clarno soil is in capability unit I–2, pasture group F, windbreak group 3; Stickney soil is in capability unit IIs–1, pasture group E, windbreak group 4.

Crossplain Series

The Crossplain series consists of deep, poorly drained, nearly level, loamy soils on uplands, in swales and along shallow depressed drainageways. These soils formed in alluvium that washed from adjacent soils and in the underlying glacial drift. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is very dark gray clay loam about 9 inches thick. The subsoil, about 19 inches thick, is very dark gray and dark gray heavy clay loam in the upper part, gray heavy clay loam in the middle part, and gray calcareous clay loam in the lower part. The underlying material is gray calcareous clay loam and heavy loam.

Crossplain soils have high fertility and organic-matter content. Permeability is slow or moderately slow, and the available water capacity is high. These soils are subject to flooding for short periods, and they also have a seasonal high water table at a depth of 1 to 4 feet early in the growing season.

Most areas are cultivated, but a few remain in native grassland and are used for hay and for grazing.

Representative profile of Crossplain clay loam, in an area of Crossplain-Harps complex, in cultivation, 2,204 feet east and 175 feet south of the northwest corner of sec. 25, T. 100 N., R. 56 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; few fine faint mottles of yellowish brown (10YR 5/6) moist; weak coarse and medium subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

B21tg—9 to 15 inches; very dark gray (5Y 3/1) and dark gray (5Y 4/1) heavy clay loam, very dark gray (5Y 3/1) and black (5Y 2/1) moist; few fine faint mottles of yellowish brown (10YR 5/6) moist; weak medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, firm, slightly sticky and plastic; shiny coats on vertical faces of peds; neutral; clear wavy boundary.

B22tg—15 to 23 inches; gray (5Y 5/1) heavy clay loam, dark gray (5Y 4/1) moist; common fine and medium distinct mottles of yellowish brown (10YR 5/6) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, firm, sticky and plastic; tongues, ½ inch to 1½ inches wide, of black (5Y 2/1) moist; shiny coats on vertical faces of peds; common fine dark segregations of iron and manganese oxides; neutral; clear wavy boundary.

B3gca—23 to 28 inches; gray (5Y 6/1) clay loam, olive gray (5Y 5/2) moist; many medium distinct mottles of yellowish brown (10YR 5/6) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky and slightly plastic; shiny coats on vertical faces of peds; many fine dark segregations and few dark concretions of iron and manganese oxides; many medium segregations and common medium concretions of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C1gca—28 to 36 inches; gray (5Y 6/1) clay loam, olive gray (5Y 5/2) moist; many coarse and medium distinct mottles of light olive brown (2.5Y 5/6) moist; massive; laminations evident; very hard, friable, slightly sticky and slightly plastic; common medium dark segregations and common fine dark concretions of iron and manganese oxides; many medium segregations and common medium concretions of lime; strong effervescence; mildly alkaline; diffuse boundary.

C2gca—36 to 48 inches; gray (5Y 6/1) heavy loam, olive gray (5Y 5/2) moist; many medium and coarse prominent mottles of light olive brown (2.5Y 5/6) moist; massive; laminations evident; very hard, friable, slightly sticky and slightly plastic; common medium dark segregations and few medium dark concretions of iron and manganese oxides; many medium segregations and few medium concretions of lime; strong effervescence; mildly alkaline; diffuse boundary.

C3g—48 to 60 inches; gray (5Y 6/1) heavy loam,

olive gray (5Y 5/2) moist; many coarse and medium prominent mottles of light olive brown (2.5Y 5/6) moist; massive; laminations evident; very hard, friable, slightly sticky and slightly plastic; common medium dark segregations and few fine dark concretions of iron and manganese oxides; few medium segregations of lime; strong effervescence; mildly alkaline.

The solum is 20 to 40 inches thick. Depth to free carbonates is 20 to 32 inches. The A horizon is very dark gray or dark gray in hue of 10YR or 2.5Y. It is clay loam or loam and in places lacks mottles. It is slightly acid to mildly alkaline and is 6 to 10 inches thick. The B2t horizon is very dark gray to olive gray in hue of 2.5Y or 5Y and is heavy clay loam or light clay. Some profiles do not have tongues of darker material in the B2t horizon. The B2t horizon is slightly acid to mildly alkaline and is 14 to 22 inches thick. Some profiles do not have a B3 horizon. The B3 and C horizons are gray to pale olive in hue of 2.5Y or 5Y and are neutral to moderately alkaline. In places, thin lenses of sandy or gravelly material are in the lower part of the C horizon below a depth of 40 inches.

Crossplain soils are mapped with Harps and Prosper soils and are similar to Tetonka and Worthing soils. They are deeper to lime than Harps soils and are more poorly drained and have a more clayey B horizon than Prosper soils. In contrast to Tetonka soils, Crossplain soils lack an A2 horizon. They have a thinner B2t horizon than Worthing soils.

Ct—Crossplain-Harps complex. These soils are nearly level and are in upland basins that consist of meandering drainageways or swales and very slight rises. Areas are 5 to 85 acres in size. Slopes are 0 to 2 percent. The mapped areas are about 45 percent Crossplain soil, 30 percent Harps soil, and 25 percent other soils. The Crossplain soil is in the lower part of the landscape and has a clay loam surface layer. The Harps soil is on very slight rises and has a loam surface layer. The Crossplain soil has the profile described as representative of the series, but in a few places the underlying material below a depth of 40 inches is sand and gravel.

Included with these soils in mapping are small areas of Clarno, Davison, Prosper, and Tetonka soils. Clarno and Davison soils are on some of the very slight rises above the Harps soil. Prosper soils are in some of the drainageways or swales. Tetonka soils are in small closed depressions.

Runoff is slow to very slow, and water ponds in some of the low areas. Farming commonly is delayed by wetness resulting from a high water table early in the growing season and from flooding. In wet years, crop growth is seriously affected. Wetness is the main concern of management.

Most areas are cultivated. The soils are better suited to late-seeded row crops than to small grain. Alfalfa also is an important crop. Capability unit IIw–1, pasture group A, windbreak group 2.

Davis Series

The Davis series consists of deep, moderately well drained, gently sloping to moderately sloping, loamy soils on foot slopes and fans adjacent to stream valleys. These soils formed in alluvium. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is dark gray loam about 9 inches thick. The subsoil, about 18 inches thick, is loam that is dark gray in the upper part, dark grayish brown in the middle part, and grayish brown in the lower part. The underlying material, to a depth of 52 inches, is pale brown calcareous loam. Pale brown calcareous gravelly sandy loam is at a depth of 52 inches.

Davis soils have high fertility and organic-matter content. Permeability is moderate, and the available water capacity is high. Most areas receive runoff from adjacent uplands and are subject to flooding for short periods.

Some areas are cultivated, and some remain in native grassland and are used for grazing and for hay.

Representative profile of Davis loam, 2 to 6 percent slopes, in cultivation, 995 feet east and 85 feet north of the southwest corner of sec. 31, T. 102 N., R. 58 W.

Ap—0 to 9 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; slightly acid; abrupt smooth boundary.

B21—9 to 15 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; clear smooth boundary.

B22—15 to 22 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

B3—22 to 27 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

C1ca—27 to 52 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common medium and fine segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—52 to 60 inches; pale brown (10YR 6/3) gravelly sandy loam, brown (10YR 5/3) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline.

The solum is 24 to 50 inches thick. Depth to free carbonates is 20 to 40 inches. Some pedons have a buried A horizon below a depth of 36 inches. The A

horizon is very dark gray to dark grayish brown and is 6 to 12 inches thick. The B horizon commonly is loam, but in places it is silt loam or light clay loam. In places the B3 horizon is calcareous. The C horizon is very dark gray to light yellowish brown in hue of 10YR or 2.5Y. It commonly is loam and usually is stratified with textures that range from gravelly sandy loam to silty clay loam. The C horizon is mildly alkaline or moderately alkaline.

Davis soils are near Clamo, Clarno, and Ethan soils. They are better drained and are less clayey than Clamo soils and have dark colors to a greater depth than Clarno and Ethan soils.

DaB—Davis loam, 2 to 6 percent slopes. This gently sloping soil is on foot slopes and fans on the edge of stream valleys. Areas are long and narrow and range from 15 to 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Chaska, Clarno, Delmont, Henkin, Lamo, and Salmo soils. Chaska, Lamo, and Salmo soils are on bottom lands that finger into or through some areas. Clarno soils are in the higher part of the landscape. Delmont and Henkin soils are on some of the fans.

Runoff is medium. This soil receives additional moisture from adjacent soils. Controlling erosion is the main concern of management.

Some of the wider areas are used for crops. This soil is well suited to all crops commonly grown in the survey area. Many areas are in native or tame grass and are used for pasture and hay. Capability unit IIe–1, pasture group K, windbreak group 1.

DaC—Davis loam, 6 to 9 percent slopes. This moderately sloping soil is on foot slopes that lie between steep stream breaks and bottom lands in Hanson County. Areas are narrow and range from 5 to 20 acres in size. The profile of this Davis soil is shallower to lime than the profile described as representative of the series.

Included with this soil in mapping are small areas of Chaska, Clamo, Clarno, Ethan, and Henkin soils. Chaska and Clamo soils are on bottom lands in the lower part of the landscape. Clarno and Ethan soils are in the higher part of the landscape. Henkin soils are intermingled with Davis soils in some areas.

Runoff is medium, and runoff from adjacent steep soils commonly crosses the areas. The hazard of erosion is severe. Controlling erosion is the main concern of management.

Most areas remain in native grassland and are used for hay and for grazing. A few areas are cultivated. This soil is well suited to most crops grown in the survey area. Capability unit IIIe–2, pasture group K, windbreak group 1.

Davison Series

The Davison series consists of deep, moderately well drained, nearly level to undulating, calcareous, loamy soils on uplands. These soils formed in glacial meltwater deposits. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is grayish brown loam about 14 inches thick. The underlying material, to a depth of 37 inches, is light yellowish brown loam and silt loam. Below this it is pale yellow fine sandy loam and very fine sandy loam. All layers are calcareous.

Davison soils have medium fertility and moderate organic-matter content. Permeability is moderate, and the available water capacity is moderate or high. Early in the growing season these soils have a seasonal high water table at a depth of 1.5 to 6 feet.

Most areas are cultivated, but a few areas remain in native grassland and are used for hay and for grazing.

Representative profile of Davison loam, in an area of Davison soils, 0 to 3 percent slopes, in cultivation, 365 feet south and 320 feet east of the northwest corner of sec. 30, T. 101 N., R. 57 W.

Ap—0 to 9 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, very friable; strong effervescence; mildly alkaline; abrupt smooth boundary.

A12—9 to 14 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, friable; violent effervescence; moderately alkaline; clear wavy boundary.

C1ca—14 to 25 inches; light yellowish brown (2.5Y 6/3) loam, olive brown (2.5Y 4/4) moist; weak coarse and medium subangular blocky structure; slightly hard, friable; violent effervescence; moderately alkaline; clear wavy boundary.

C2—25 to 37 inches; light yellowish brown (2.5Y 6/4) silt loam, olive brown (2.5Y 4/4) moist; few fine and medium distinct mottles of olive yellow (2.5Y 6/6); massive; laminations evident; slightly hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; abrupt smooth boundary.

C3—37 to 50 inches; pale yellow (2.5Y 7/4) fine sandy loam, olive brown (2.5Y 4/4) moist; common medium distinct mottles of olive yellow (2.5Y 6/6); massive; soft, very friable; slight effervescence; moderately alkaline; abrupt smooth boundary.

C4—50 to 60 inches; pale yellow (2.5Y 7/4) very fine sandy loam, olive brown (2.5Y 4/4) moist; common medium distinct mottles of olive yellow (2.5Y 6/6) and yellowish brown (10YR 5/6); massive; laminations evident; soft, very friable; slight effervescence; moderately alkaline.

Free carbonates commonly are at the surface, but some profiles in native grassland are leached to a depth of 6 inches. The A horizon is very dark gray to grayish brown and is 7 to 15 inches thick. It commonly is loam, but in places it is very fine sandy loam or silt loam. Some profiles have an AC horizon. The Cca

horizon has a calcium carbonate equivalent of 15 to 30 percent and is 10 to 20 inches thick. The C horizon commonly is stratified with layers ranging from sandy loam to clay loam. In places, the C horizon below 40 inches is fine sand, and in places it is loam or clay loam glacial till.

Davison soils contain more calcium carbonate than the nearby Bonilla, Clarno, and Hand soils and are not so well drained as Clarno and Hand soils.

DbA—Davison soils, 0 to 3 percent slopes. This soil is nearly level to gently undulating and is on uplands. Areas range from 5 to 60 acres in size. They consist of very slight rises separated by narrow swales or drainageways and by small closed depressions. Davison soils are on the rises and make up 40 to 70 percent of the individually mapped areas. The surface layer in many mapped areas is loam, but in some places it is silt loam or very fine sandy loam. The Davison loam in this mapping unit has the profile described as representative of the series, but in places the lower part of the underlying material is entirely silt loam or silty clay loam.

Included with these soils in mapping are small areas of Bonilla, Crossplain, Hand, Henkin, Prosper, and Tetonka soils. The Bonilla, Crossplain, and Prosper soils are in the narrow swales or drainageways. The Hand and Henkin soils are on some of the rises. The Tetonka soils are in closed depressions, some of which are shown on the maps by a symbol for wet spots.

Runoff is slow and is ponded in some of the low spots. Farming is delayed in some years by wetness resulting from a high water table. The high lime content affects crop growth and also causes soil blowing. Controlling soil blowing is the main concern of management.

Most areas are cultivated. These soils are moderately well suited to all crops commonly grown in the survey area. Capability unit IIe–4, pasture group F, windbreak group 1.

DcB—Davison-Onita complex, 2 to 6 percent slopes. These soils are undulating and are on uplands in Hutchinson County. Areas are irregular in shape and range from 5 to 50 acres in size. The mapped areas are about 45 percent Davison soil, 30 percent Onita soil, and 25 percent other soils. The Davison soil is on the rises and has a loam surface layer. The Onita soil is in swales and shallow depressions and has a silt loam surface layer. It has a thicker surface layer than is typical of the series.

Included with these soils in mapping are small areas of Homme and Whitewood soils. The Homme soil is on some of the rises. The Whitewood soil is in the lower part of some of the swales and shallow depressions.

Runoff is medium, and it collects on the Onita soil. In most years this additional moisture is beneficial to crops. The high lime content of the Davison soil affects crop growth and also causes the soil to blow easily. Controlling erosion and soil blowing is the main concern of management.

Most areas are cultivated. These soils are moderately well suited to all crops commonly grown in the survey area. Windbreak group 1; Davison soil is in capability unit IIIe–8, pasture group F; Onita soil is in capability unit IIe–1, pasture group K.

Delmont Series

The Delmont series consists of somewhat excessively drained, nearly level to rolling, loamy soils on terraces and uplands. They are shallow over gravelly sand. These soils formed in alluvium. The native vegetation consisted of mid and short grasses.

In a representative profile the surface layer is very dark gray loam about 6 inches thick (fig. 7). The subsoil, about 10 inches thick, is very dark gray loam. The underlying material is calcareous gravelly sand that is light gray to a depth of 40 inches and is brown and reddish brown below that.

Delmont soils have medium fertility and moderate organic-matter content. Permeability is moderate in the subsoil and rapid in the underlying material. The available water capacity is low.

Many areas are used for crops, but some remain in native grassland and are used for grazing.

Representative profile of Delmont loam, 0 to 3 percent slopes, in cultivation, 820 feet south and 130 feet east of the northwest corner of sec. 5, T. 97 N., R. 58 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure

Figure 7.—**Profile of Delmont loam, 0 to 3 percent slopes.**

parting to weak fine granular; slightly hard, very friable; neutral; abrupt wavy boundary.

B2—6 to 16 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, friable; neutral; abrupt wavy boundary.

IIC1—16 to 19 inches; light gray (10YR 7/1) gravelly sand, dark grayish brown (10YR 4/2) moist; single grained; loose; slight effervescence; mildly alkaline; gradual wavy boundary.

IIC2ca—19 to 40 inches; light gray (10YR 7/1) gravelly sand, dark grayish brown (10YR 4/2) moist; single grained; loose; gravel coated with lime; strong effervescence; moderately alkaline; gradual irregular boundary.

IIC3—40 to 60 inches; brown (7.5YR 5/4) and reddish brown (5YR 5/4) gravelly sand, reddish brown (5YR 4/4) moist; single grained; loose; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to gravelly sand are 10 to 20 inches. The solum is neutral or mildly alkaline. The A horizon is very dark gray to dark grayish brown, and in places it is very fine sandy loam or silt loam. It is 4 to 7 inches thick. The B2 horizon is very dark gray to grayish brown. Some profiles have a thin B3 or B3ca horizon of gravelly loam or gravelly sandy loam. In places the gravelly sand in the C horizon contains fine fragments of shale and clay balls that range from ½ inch to 5 inches in diameter.

Delmont soils are mapped with Talmo soils and are near the Dimo, Enet, Henkin, and Storla soils. They are shallower over gravelly sand than the Dimo, Enet, and Storla soils. Delmont soils contain more clay and less sand in the B horizon and more gravel in the C horizon than the Henkin soils. They are deeper over gravelly sand than the Talmo soils.

DeA—Delmont loam, 0 to 3 percent slopes. This soil is nearly level to gently undulating and is on terraces. Areas are irregular in shape and range from 5 to 150 acres in size. Some mapped areas are nearly level, but some consist of very slight rises separated by shallow swales. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Dimo, Henkin, and Storla soils. Dimo soils are in swales and drainageways. The Henkin and Storla soils are on some of the very slight rises.

Runoff is slow to medium. This soil is droughty and is subject to soil blowing. Conserving moisture and controlling soil blowing are the main concerns of management.

Many areas are used for crops. Early-maturing crops such as small grain and tame grasses are better suited than corn and alfalfa. This soil is a fair source of gravel for construction uses. Capability unit IIIs–3, pasture group D, windbreak group 10.

DeB—Delmont loam, 3 to 6 percent slopes. This is an undulating soil on uplands and terraces. Areas are irregular in shape and range from 5 to 50 acres in size. Slopes are short and convex. In places the lower part of the subsoil is gravelly sandy loam; otherwise this soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Dimo, Henkin, Storla, and Talmo soils. Dimo soils are in swales and along drainageways, Henkin and Storla soils are on foot slopes, and Talmo soils are on the tops of ridges and knolls.

Runoff is medium. The hazards of erosion and soil blowing are moderate. This soil is droughty because of the underlying gravelly sand. Conserving moisture and controlling erosion and soil blowing are the main concerns of management.

Some areas are cultivated, but many remain in native grassland and are used for pasture. This soil is poorly suited to most crops grown in the survey area. Small grain and tame grasses are better suited than deep-rooted crops such as corn and alfalfa. Some areas are a potential source of gravel for construction use. Capability unit IVs–2, pasture group D, windbreak group 10.

DmB—Delmont-Rock outcrop complex, 2 to 9 percent slopes. The soils in this complex are undulating to gently rolling and are in Hanson County. Most areas are on the sides of stream valleys, but a few are on bottom lands. The mapped areas are about 50 percent Delmont soil, 35 percent Rock outcrop, and 15 percent other soils. The Delmont soil has a loam surface layer. It is underlain by hard bedrock, typically at a depth of 20 to 40 inches. Depth to bedrock ranges from 10 to more than 40 inches. The Rock outcrop consists of quartzite that is exposed at the surface and in ledges up to 15 feet thick on low escarpments. The Rock outcrop is so closely intermingled with the Delmont soil that it was impractical to separate them in mapping.

Included with this complex in mapping are small areas of Chaska, Enet, and Salmo soils. Chaska and Salmo soils are on bottom lands along streams and drainageways. Enet soils are intermingled with Delmont soils. Also included is a loam soil that is less than 10 inches deep over quartzite.

Runoff is medium. The hazards of erosion and soil blowing are severe if the plant cover on the Delmont soil is removed. The hazards of erosion and soil blowing are the main concerns of management.

All areas are in native grassland and are used for grazing. The Rock outcrop is barren of vegetation, and it is so intricately intermingled with the Delmont soil that farming is impractical. The Delmont soil is in capability unit VIe–6, pasture group D, windbreak group 10; Rock outcrop is in capability unit VIIIs–1 and is not placed in a pasture group or windbreak group.

DnD—Delmont-Talmo complex, 6 to 12 percent slopes. This complex consists of gently rolling to rolling soils on well-rounded ridges and knolls on uplands. Areas are irregular in shape and range from 10 to 50 acres in size. Slopes are short and convex. The areas are about 55 percent Delmont soil, 25 percent Talmo soil, and 20 percent other soils. The Delmont soil is on the sides of the ridges and knolls and has a loam surface layer. The Talmo soil is in the higher part of the landscape on the tops and upper side slopes of the ridges and knolls. The Talmo soil has the profile de-

scribed as representative of the Talmo series. It has a surface layer of gravelly loam.

Included with these soils in mapping are small areas of Dimo, Hand, and Storla soils. The Dimo and Storla soils are in narrow swales and along drainageways. The Hand soil is on the lower side slopes of some of the ridges and knolls.

Runoff is slow to medium. These soils are droughty and are subject to erosion and soil blowing if the plant cover is removed. Conserving moisture and controlling erosion and soil blowing are the main concerns of management.

Most areas remain in native grassland and are used for pasture. A few areas are cultivated, but crops grow poorly. Capability unit VIe-6; windbreak group 10; Delmont soil is in pasture group D; Talmo soil is not placed in a pasture group.

Dimo Series

The Dimo series consists of somewhat poorly drained, nearly level, loamy soils that are moderately deep over gravelly sand. These soils are in swales and along drainageways on uplands and terraces. They formed in alluvium washed from adjacent soils. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is dark gray loam about 9 inches thick. The subsoil, about 17 inches thick, is dark gray light clay loam in the upper part, very dark gray light clay loam in the middle part, and dark grayish brown sandy clay loam in the lower part. Calcareous gravelly sand is at a depth of 26 inches.

Dimo soils have medium fertility and high organic-matter content. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. The available water capacity is low or moderate. These soils are subject to flooding for very brief periods, and they have a seasonal high water table at a depth of 2 to 6 feet.

Most areas are used for crops, but a few areas remain in native grassland and are used for hay and for grazing.

Representative profile of Dimo loam, in cultivation, 832 feet south and 585 feet east of the northwest corner of sec. 16, T. 100 N., R. 60 W.

Ap—0 to 9 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak coarse and medium subangular blocky structure; hard, friable; medium acid; abrupt smooth boundary.

B21—9 to 15 inches; dark gray (10YR 4/1) light clay loam, black (10YR 2/1) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; hard, friable; slightly acid; clear wavy boundary.

B22—15 to 19 inches; very dark gray (2.5Y 3/1) light clay loam, black (2.5Y 2/1) moist; few fine faint mottles of light olive brown (2.5Y 5/6) moist; weak medium prismatic structure parting to weak and moderate medium and coarse subangular blocky; hard, friable; shiny coats on vertical faces of peds; neutral; clear wavy boundary.

B23—19 to 26 inches; dark grayish brown (2.5Y 4/2) sandy clay loam, very dark grayish brown (2.5Y 3/2) moist; common medium and coarse distinct mottles of light olive brown (2.5Y 5/6) moist; moderate coarse prismatic structure parting to moderate coarse subangular blocky; hard, friable; patchy shiny coats on faces of peds; common fine dark segregations and fine dark concretions of iron and manganese oxides; neutral; gradual wavy boundary.

IIC1—26 to 40 inches; multicolored gravelly sand; many fine to coarse prominent mottles of dark yellowish brown (10YR 4/4) and light yellowish brown (2.5Y 5/6) moist; single grained; loose; many medium and coarse dark segregations and fine dark concretions of iron and manganese oxides; slight effervescence; mildly alkaline; gradual wavy boundary.

IIC2—40 to 60 inches; multicolored gravelly sand; many fine to coarse prominent mottles of dark yellowish brown (10YR 4/4) and light yellowish brown (2.5Y 5/6) moist; single grained; loose; many medium and coarse dark segregations and fine and medium dark concretions of iron and manganese oxides; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to gravelly sand are 20 to 40 inches and generally correspond with the depth to free carbonates. The A horizon is very dark gray to dark grayish brown. It commonly is loam or clay loam, but in places is silt loam. It is medium acid to neutral and is 7 to 12 inches thick. Some pedons have a B1 horizon. The B2 horizon is very dark gray to grayish brown and in places is loam. Some profiles have a B3 or B3ca horizon that is intermediate in texture between the B2 and IIC horizons. In places the IIC horizon is stratified by thin lenses of finer textured material.

Dimo soils are near the Crossplain, Delmont, Enet, Prosper, and Storla soils. They have a less clayey B horizon than the Crossplain soils and are deeper over gravelly sand than the Delmont soils. Dimo soils are more poorly drained than Enet and Prosper soils and are less calcareous than the Storla soils.

Do—Dimo loam. This is a nearly level soil in swales and along drainageways on uplands and terraces. Areas are long and narrow and range from 5 to 20 acres in size. Slopes are 0 to 2 percent and generally are concave. In a few places the surface layer is clay loam or silt loam.

Included with this soil in mapping are small areas of Crossplain, Storla, and Tetonka soils. Crossplain soils are intermingled with the Dimo soil in some areas. Storla soils are on the edge of the mapped areas. Tetonka soils are in low areas.

Runoff is slow. This soil is subject to flooding for very brief periods because of runoff received from adjacent soils. Fieldwork is delayed in some years because of wetness from flooding and a seasonal high

water table. In dry years the soil is droughty because of the underlying gravelly sand. Conserving moisture is the main concern of management.

Most areas are used for crops. This soil is moderately well suited to most crops grown in the survey area, but early-maturing crops such as small grain are better suited than row crops during dry years. Capability unit IIs–3, pasture group D, windbreak group 3.

Dudley Series

The Dudley series consists of deep, moderately well drained, nearly level, silty soils on uplands. These soils formed in glacial till. They have a claypan subsoil. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is dark gray silt loam about 8 inches thick. The subsurface layer is gray silt loam about 2 inches thick. The subsoil, about 18 inches thick, is clay loam that is very dark grayish brown in the upper part, dark grayish brown and grayish brown in the middle part, and light brownish gray in the lower part. The lower part is calcareous and has spots and streaks of soft lime and gypsum crystals that extend into the underlying material. The underlying material is light brownish gray and light yellowish brown calcareous clay loam.

Dudley soils have medium fertility and moderate organic-matter content. Some parts of the subsoil and underlying material have detrimental amounts of sodium. Permeability is slow or very slow, and the available water capacity is moderate or high.

Most areas are cultivated, and some remain in native grassland and are used for grazing and for hay.

Representative profile of Dudley silt loam, in an area of Dudley-Stickney complex, 0 to 2 percent slopes, in cultivation, 1,380 feet north and 200 feet east of the southwest corner of sec. 27, T. 98 N., R. 57 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak coarse subangular blocky structure parting to weak fine granular; hard, friable, slightly sticky and slightly plastic; slightly acid; clear smooth boundary.

A2—8 to 10 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak thin platy structure; soft, very friable; neutral; abrupt wavy boundary.

B21t—10 to 13 inches; very dark grayish brown (10YR 3/2) heavy clay loam, very dark brown (10YR 2/2) moist; strong medium and coarse columnar structure parting to moderate medium blocky; extremely hard, very firm, sticky and plastic; thin continuous coatings of gray (10YR 5/1) on rounded tops of columns; shiny coatings on all faces of peds; mildly alkaline; clear wavy boundary.

B22t—13 to 18 inches; dark grayish brown (10YR 4/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; strong medium prismatic structure parting to strong medium blocky; extremely hard, very firm, sticky and plastic; tongues of black organic matter on faces of peds; shiny coatings on all faces of peds; mildly alkaline; clear irregular boundary.

B23t—18 to 21 inches; grayish brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate coarse and medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; shiny coatings on vertical faces of peds; few fine nests and threads of gypsum crystals; slight effervescence; moderately alkaline; clear wavy boundary.

B31cs—21 to 24 inches; light brownish gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/3) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; common fine and medium nests of gypsum crystals; few medium segregations of lime; strong effervescence; moderately alkaline; gradual irregular boundary.

B32cacs—24 to 28 inches; light brownish gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/3) moist; moderate coarse prismatic structure parting to moderate coarse and medium subangular blocky; very hard, firm, sticky and plastic; many medium and fine nests of gypsum crystals; many coarse segregations of lime; strong effervescence; strongly alkaline; diffuse boundary.

C1cacs—28 to 40 inches; light brownish gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/3) moist; massive; hard, friable, slightly sticky and slightly plastic; common medium and fine nests of gypsum crystals; common medium segregations of lime; strong effervescence; strongly alkaline; gradual boundary.

C2cacs—40 to 60 inches; light yellowish brown (2.5Y 6/3) clay loam, olive brown (2.5Y 4/3) moist; common medium distinct mottles of light olive brown (2.5Y 5/3) and dark brown (7.5YR 4/4) moist; massive; hard, friable, slightly sticky and slightly plastic; common medium and fine nests of gypsum crystals; common fine and medium segregations of lime; strong effervescence; strongly alkaline.

The solum is 20 to 36 inches thick. Depth to free carbonates is 18 to 26 inches. The A1 horizon is very dark gray to grayish brown and is 5 to 8 inches thick. The A2 horizon is gray or light gray and is 1 to 3 inches thick. In profiles in cultivated areas, all or part of the A2 horizon commonly is included in the Ap horizon. The B2t horizon is very dark gray to grayish brown and commonly is clay loam or light clay, but in places it is silty clay loam or silty clay. It is neutral to moderately alkaline and is 8 to 14 inches thick. The B3 horizon is dark grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is mildly alkaline to strongly alkaline. The C horizon is grayish brown to pale yellow

and in places is loam. It is mildly alkaline to strongly alkaline.

Dudley soils are mapped with Stickney soils and are near Durrstein soils. They are better drained and have a thicker A horizon than Durrstein soils, and they have a thinner A horizon than Stickney soils.

DsA—Dudley-Stickney complex, 0 to 2 percent slopes. This complex is on upland flats. Many poorly defined drainageways and a few small depressions are in the areas. The areas range from 5 to 200 acres in size. Slopes are mostly nearly level but range to 4 percent in parts of Hutchinson County. This complex is about 40 percent Dudley soil, 35 percent Stickney soil, and 25 percent other soils. The Dudley and Stickney soils are closely intermingled. The Dudley soil is on very slight rises above the Stickney soil, which is in the slightly depressed lower part of the landscape. Both soils have the profile described as representative of their series. The Dudley soil has a surface layer of silt loam, and the Stickney soil has a surface layer of silty clay loam.

Included with these soils in mapping are small areas of Clarno, Crossplain, Davison, Harps, Prosper, and Tetonka soils. The Clarno, Davison, and Harps soils are on some of the rises. The Crossplain and Prosper soils are along some of the poorly defined drainageways. The Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is slow, and the soils dry slowly. These soils are difficult to work, lose their tilth, and compact if farmed when wet. The claypan subsoil absorbs water slowly and releases moisture slowly to plants. It also restricts root development and causes crops to grow unevenly, especially during periods of drought.

Most areas are used for crops. These soils are moderately well suited to all crops grown in the survey area. Small grain, sorghum, and alfalfa are better suited than corn. The Dudley soil is in capability unit IVs–3, pasture group C, windbreak group 9; the Stickney soil is in capability unit IIs–1, pasture group E, windbreak group 4.

Durrstein Series

The Durrstein series consists of deep, poorly drained, nearly level, silty soils along drainageways on uplands. The soils formed in alluvium and in the underlying glacial till. They have a claypan subsoil. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is gray silt loam about 1 inch thick. The subsoil, about 17 inches thick, is silty clay. It is dark gray in the upper part and gray in the lower part. Spots and streaks of salt are below a depth of 5 inches. The underlying material is gray and light gray calcareous clay loam that contains spots and streaks of lime and gypsum.

Durrstein soils have low fertility and moderate organic-matter content. Permeability is very slow or slow, and the available water capacity is low or moderate. These soils are subject to flooding for brief periods. They have a seasonal high water table at a depth of 1 to 6 feet.

Most areas remain in native grassland and are used for grazing, but a few areas are cultivated.

Representative profile of Durrstein silt loam, in native grass, 590 feet north and 533 feet east of the southwest corner of sec. 26, T. 100 N., R. 60 W.

A2—0 to 1 inch; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak thin platy structure; soft, very friable, slightly acid; abrupt wavy boundary.

B21t—1 to 5 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate medium structure; very hard, firm, sticky and plastic; gray (10YR 5/1) coatings on rounded column tops; shiny coatings on vertical faces of peds; mildly alkaline; clear wavy boundary.

B22tsa—5 to 12 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; strong coarse prismatic structure parting to moderate medium and coarse subangular blocky; very hard, firm, sticky and plastic; shiny coatings on vertical faces of peds; many fine nests of salts; mildly alkaline; clear irregular boundary.

B3cs—12 to 18 inches; gray (2.5Y 5/1) silty clay, very dark gray (2.5Y 3/1) moist; moderate coarse prismatic structure parting to moderate coarse subangular blocky; very hard, firm, sticky and plastic; shiny coatings on vertical faces of peds; many fine nests of gypsum crystals; slight effervescence; mildly alkaline; gradual wavy boundary.

C1gca—18 to 30 inches; gray (5Y 6/1) heavy clay loam, dark gray (5Y 4/1) and olive gray (5Y 5/2) moist; common medium distinct mottles of olive yellow (2.5Y 6/6) in the lower part; moderate medium and coarse prismatic structure parting to moderate medium and coarse subangular blocky; very hard, firm, sticky and plastic; few fine nests of gypsum crystals; common medium and coarse segregations and fine threads of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2gcacs—30 to 42 inches; light gray (5Y 7/2) clay loam, olive gray (5Y 5/2) moist; common fine and medium distinct mottles of olive yellow (2.5Y 6/6) moist; massive; hard, firm, sticky and plastic; many medium nests of gypsum crystals; many medium segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C3gcs—42 to 60 inches; light gray (5Y 7/2) clay loam, olive gray (5Y 5/2) moist; many coarse prominent mottles of olive yellow (2.5Y 6/6) moist; massive; hard, friable, slightly sticky and slightly plastic; many medium dark segregations of iron and manganese oxides; many medium nests of gypsum crystals; few medium

segregations of lime; strong effervescence; moderately alkaline.

The solum is 15 to 30 inches thick. Depth to segregations of salts and to free carbonates is 5 to 15 inches. Some profiles have an A1 horizon that is 2 inches thick or less. The A2 horizon is gray to light brownish gray and is 1 to 4 inches thick. The B2t horizon is dark gray to grayish brown in hue of 10YR or 2.5Y. It is silty clay, clay, or clay loam and is 6 to 11 inches thick. The B3 horizon is gray to light olive gray in hue of 2.5Y or 5Y and is silty clay, clay, silty clay loam, or clay loam. The C horizon has hue of 5Y to 2.5Y. In places it is stratified below a depth of 40 inches with thin layers of coarser material. Some profiles have a buried A horizon in the lower part of the C horizon.

Durrstein soils are near Dudley and Tetonka soils and are similar to James soils. They have a thinner A horizon than all of these soils, they are more poorly drained than the Dudley soils, and they contain more sodium than the James and Tetonka soils.

Du—Durrstein silt loam. This soil is nearly level and is along upland drainageways. Most of the areas are long and narrow and range from 5 to 80 acres in size. Slopes are 0 to 2 percent. The surface generally is uneven because of low mounds that rise a few inches above the intervening low areas. These low areas range from 3 to 10 feet in diameter.

Included with this soil in mapping are small areas of Tetonka and Worthing soils in closed depressions that are less than 2 acres in size. Also included in some of the low areas is a saline soil that has salt accumulations at or above a depth of 5 inches.

Runoff is slow, and water ponds in the low areas. This soil is subject to flooding for brief periods, and it has a seasonal high water table. It also has a claypan that restricts root growth and absorbs water slowly, and it has a high salt content. This soil is not suited to cultivation because of wetness, high salt content, and poor tilth.

Most areas remain in native grassland and are used for pasture. Capability unit VIw–3, pasture group J, windbreak group 10.

Egan Series

The Egan series consists of deep, well drained, gently sloping and moderately sloping soils on uplands. These soils formed in silty glacial drift and the underlying glacial till. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark grayish brown silt loam about 8 inches thick. The subsoil, about 15 inches thick, is silty clay loam that is brown in the upper part, yellowish brown in the middle part, and light yellowish brown in the lower part. The lower part is calcareous and has spots of soft lime that extend into the underlying material. The underlying material, to a depth of 33 inches, is light yellowish brown calcareous silty clay loam. Below this it is light brownish gray and light yellowish brown, calcareous clay loam.

Egan soils have medium to high fertility and moderate to high organic-matter content. Permeability is moderate in the subsoil and moderately slow or slow in the underlying material. The available water capacity is high.

Most areas are cultivated, but a few remain in native grassland and are used for hay and for grazing.

Representative profile of Egan silt loam, in an area of Egan and Wentworth silt loams, 2 to 6 percent slopes, in cultivation, 1,925 feet south and 250 feet east of the northwest corner of sec. 1, T. 97 N., R. 56 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; slightly acid; abrupt smooth boundary.

B21—8 to 13 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky and slightly plastic; coatings of dark grayish brown (10YR 4/2) on faces of peds; slightly acid; clear wavy boundary.

B22—13 to 19 inches; yellowish brown (10YR 5/4) silty clay loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; coatings of dark grayish brown (10YR 4/2) on faces of peds; slightly acid; clear wavy boundary.

B3ca—19 to 23 inches; light yellowish brown (2.5Y 6/3) silty clay loam, olive brown (2.5Y 4/3) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine and medium concretions of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C1ca—23 to 33 inches; light yellowish brown (2.5Y 6/3) silty clay loam, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; many medium concretions and segregations of lime; strong effervescence; mildly alkaline; clear wavy boundary.

IIC2—33 to 50 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; many coarse prominent mottles of yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) moist; weak coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few medium concretions and fine threads of lime; strong effervescence; mildly alkaline; gradual smooth boundary.

IIC3—50 to 60 inches; light yellowish brown (2.5Y 6/3) clay loam, olive brown (2.5Y 4/3) moist; many medium prominent

mottles of gray (5Y 6/1) and strong brown (7.5YR 5/6) moist; weak coarse subangular blocky structure; few fine dark concretions of iron and manganese oxides; few medium and fine concretions and segregations of lime; strong effervescence; mildly alkaline.

The solum is 21 to 40 inches thick. The silty material in which the soil formed is typically about 30 inches thick, but it ranges from 20 to 40 inches thick. Depth to free carbonates is 16 to 30 inches. Reaction is slightly acid or neutral in the A and B2 horizons and mildly alkaline to strongly alkaline in the B3 and C horizons. The A horizon is dark gray or dark grayish brown and in places is silty clay loam. It is 5 to 10 inches thick. The B2 horizon is dark grayish brown to light olive brown in hue of 10YR or 2.5Y and is 11 to 20 inches thick. The B3 horizon is grayish brown to light yellowish brown in hue of 10YR or 2.5Y and in places is clay loam or loam. The C horizon is grayish brown to pale yellow and has mottles that are relict from the underlying glacial till.

Egan soils are near Betts, Clarno, Ethan, and Wentworth soils. They are deeper to lime and have more silt than the Betts and Ethan soils, have more silt in the A and B horizons than the Clarno soils, and are shallower to clay loam or loam glacial till than the Wentworth soils.

EaC—Egan silt loam, 6 to 9 percent slopes. This is a moderately sloping soil on ridges and knolls on uplands in Hutchinson County. Areas range from 5 to 60 acres in size. Slopes are smooth and moderately long. In a few places the surface layer is silty clay loam, and in places the lower part of the underlying material has more silt than is typical of the series.

Included with this soil in mapping are small areas of Clarno, Ethan, Tetonka, and Whitewood soils. The Clarno and Ethan soils are on the top and upper side slopes of some of the ridges. In some cultivated areas they are moderately eroded. The Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot. Whitewood soils are in swales and along drainageways.

Runoff is medium. The hazard of erosion is severe. Controlling erosion is the main concern of management.

Most areas are cultivated. This soil is well suited to all crops commonly grown in the survey area. Capability unit IIIe–2, pasture group F, windbreak group 3.

EbC2—Egan-Betts complex, 3 to 9 percent slopes, eroded. The soils in this complex are mainly on the upper side slopes of ridges and knolls on uplands in Hutchinson County. Areas are irregular in shape and range from 5 to 40 acres in size. Slopes are short and convex. This complex consists of about 60 percent Egan soil, 25 percent Betts soil, and 15 percent other soils. The Egan soil is on the sides of ridges and knolls, and the Betts soil is on the crests of ridges and knolls. These soils are moderately to severely eroded. The Egan soil has a surface layer of silt loam or silty clay loam. It has a profile similar to the one described as representative of the series, but the surface layer and subsoil are thinner. The Betts soil has a profile in which the loam surface layer is lighter colored than the one described as representative of the Betts series because it is eroded and the subsoil has been mixed with the surface layer by plowing.

Included with these soils in mapping are small areas of Clarno and Ethan soils. They are in the higher part of the landscape near the Betts soil.

Runoff is medium to rapid. Erosion has lowered the fertility level, and the hazard of further erosion is very severe. Controlling erosion and improving fertility are the main concerns of management.

All areas are cultivated. The Egan soil is moderately well suited to all crops grown in the survey area, but the Betts soil is poorly suited to crops. Egan soil is in capability unit IVe–1, pasture group F, windbreak group 3; Betts soil is in capability unit VIe–3, pasture group G, windbreak group 10.

EgB—Egan and Wentworth silt loams, 2 to 6 percent slopes. These are gently sloping soils on uplands in Hutchinson County. Areas are irregular in shape and range from 10 to 175 acres in size. Slopes are long, smooth, and slightly convex. Some areas are mostly Egan soil, but most areas include both soils in different proportions. The Egan soil is generally on the upper part of slight rises, and the Wentworth soil is in the lower part of the landscape. Both soils have the profile described as representative of their series.

Included with these soils in mapping are small areas of Clarno, Ethan, Tetonka, and Whitewood soils. The Clarno and Ethan soils are on some of the slight rises, and in places they are moderately eroded. The Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot. The Whitewood soils are in swales and along drainageways. Also included in a few areas is a silt loam that is underlain by loamy sand at a depth of 30 to 40 inches.

Runoff is medium. The hazard of erosion is moderate. Controlling erosion is the main concern of management.

Most areas are cultivated. These soils are well suited to all crops commonly grown in the survey area. Capability unit IIe–3, pasture group F, windbreak group 3.

Enet Series

The Enet series consists of well drained, nearly level, loamy soils on uplands and terraces. They are moderately deep over gravelly sand. These soils formed in glacial melt-water deposits. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is very dark gray loam about 9 inches thick. The subsoil, about 19 inches thick, is very dark grayish brown and very dark gray loam to a depth of 24 inches and is dark grayish brown sandy loam in the lower 4 inches. Light yellowish brown and light brownish gray, calcareous gravelly sand is below a depth of 28 inches.

Enet soils have medium fertility and moderate to high organic-matter content. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. The available water capacity is moderate.

Most areas are cultivated, but a few remain in native grassland and are used for hay and for grazing.

Representative profile of Enet loam, 0 to 2 percent slopes, in cultivation, 2,105 feet south and 340 feet

west of the northeast corner of sec. 25, T. 103 N., R. 58 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak coarse subangular blocky structure parting to weak fine granular; slightly hard, very friable; slightly acid; abrupt smooth boundary.

B21—9 to 17 inches; very dark grayish brown (10YR 3/2) loam, black (10YR 2/1) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable, slightly sticky; neutral; clear wavy boundary.

B22—17 to 24 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable, slightly sticky; neutral; clear wavy boundary.

B3—24 to 28 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; mildly alkaline; clear wavy boundary.

IIC1ca—28 to 34 inches; light yellowish brown (2.5Y 6/3) gravelly sand, olive brown (2.5Y 4/3) moist; single grained; loose; gravel coated with lime; strong effervescence; mildly alkaline; gradual wavy boundary.

IIC2ca—34 to 41 inches; light brownish gray (2.5Y 6/2) gravelly sand, dark grayish brown (2.5Y 4/2) moist; single grained; loose; gravel coated with lime; strong effervescence; moderately alkaline; gradual wavy boundary.

IIC3—41 to 60 inches; light yellowish brown (2.5Y 6/3) gravelly sand, light olive brown (2.5Y 5/3) moist; few medium distinct mottles of olive yellow (2.5Y 6/6) moist; single grained; loose; strong effervescence; mildly alkaline.

The thickness of the solum, depth to free carbonates, and depth to gravelly sand are 20 to 40 inches. The A horizon is very dark gray to dark grayish brown and in places is silt loam. It is slightly acid or neutral and is 6 to 9 inches thick. The B2 horizon is very dark gray to grayish brown and commonly is loam, but in places it is light clay loam or sandy clay loam. Some profiles lack a B3 horizon, but some have a thin C1 horizon above the IIC horizon. The B3 and C1 horizons, where present, are sandy loam to loam. The IIC horizon is gravelly sand or gravelly loamy sand and in places contains fine fragments of siltstone and shale.

Enet soils are near Delmont, Dimo, Henkin, and Storla soils. They are deeper over gravelly sand than the Delmont soils and are better drained than the Dimo soils. Enet soils contain more clay and less sand in the B horizon than the Henkin soils, and they are better drained and less calcareous than the Storla soils.

EnA—Enet loam, 0 to 2 percent slopes. This nearly level soil is on uplands in Hanson County. Areas are irregular in shape and range from 5 to 60 acres in size. Slopes are slightly convex to slightly concave. In a few places the subsoil contains more sand than is typical of the series.

Included with this soil in mapping are small areas of Delmont, Dimo, Henkin, and Storla soils. The Delmont and Henkin soils are on some of the slight rises. The Dimo soils are in shallow swales or along poorly defined drainageways. The Storla soils are on the edges of the swales.

Runoff is slow. There is little or no hazard of erosion. This soil is somewhat droughty because of the underlying gravelly sand, and crops are affected during dry periods. Conserving moisture is the main concern of management.

Most areas are cultivated. This soil is moderately well suited to all crops grown in the survey area. Early-maturing crops, such as small grain, drought-resistant row crops, alfalfa, and tame grasses, are better suited than corn. Generally this soil is a good source of gravel for construction use. Capability unit IIs–3, pasture group D, windbreak group 6.

Ethan Series

The Ethan series consists of deep, well drained, undulating to steep, loamy soils on uplands. These soils formed in glacial till. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark grayish brown loam about 9 inches thick. A transition layer of light brownish gray loam about 11 inches thick is below the surface layer. The underlying material is light yellowish brown loam. The soil material is calcareous throughout.

Ethan soils have medium to low fertility and moderately low organic-matter content. Permeability is moderately slow below a depth of 28 inches. The available water capacity is high.

The rolling to steep Ethan soils are mostly in native grassland and are used for grazing. Most areas of the undulating to gently rolling Ethan soils are cultivated.

Representative profile of Ethan loam, in an area of Ethan-Betts loams, 6 to 9 percent slopes, eroded, in cultivation, 2,300 feet south and 210 feet west of the northeast corner of sec. 11, T. 98 N., R. 56 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak coarse subangular blocky structure parting to weak fine granular; slightly hard, friable; slight effervescence; mildly alkaline; abrupt wavy boundary.

ACca—9 to 20 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak medium prismatic structure parting to weak medium and coarse subangular blocky; hard, friable; many medium and coarse segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C1ca—20 to 28 inches; light yellowish brown (2.5Y 6/3) loam, olive brown (2.5Y 4/3) moist; few fine distinct mottles of

brown (7.5YR 5/4) and olive yellow (2.5Y 6/6); massive; hard, friable; many fine streaks and many medium and coarse segregations of lime; strong effervescence; mildly alkaline; diffuse boundary.

C2—28 to 60 inches; light yellowish brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) moist; common fine distinct mottles of brown (7.5YR 4/4) and olive yellow (2.5Y 6/6); massive; hard, friable, slightly sticky; common medium segregations of lime; strong effervescence; mildly alkaline.

The solum is 20 to 30 inches thick. In native grassland the depth to free carbonates ranges from 4 to 9 inches, but in most cultivated areas the surface layer is calcareous. All horizons are loam or light clay loam. The A horizon is dark gray to grayish brown and is slightly acid to mildly alkaline. It is 5 to 9 inches thick. Some profiles have a thin B2 horizon that is dark grayish brown to light olive brown in hue of 10YR or 2.5Y. Where present, the B2 horizon is 3 to 5 inches thick. The B3 and AC horizons are grayish brown to light yellowish brown and are mildly alkaline or moderately alkaline. The C horizon is light brownish gray to pale yellow. Mottles in the C horizon are relict from the glacial till.

Ethan soils are mapped with Betts, Clarno, and Homme soils. They have a thicker A horizon than Betts soils and are calcareous closer to the surface than Clarno and Homme soils.

EtB—Ethan-Betts loams, 3 to 6 percent slopes. These soils are on uplands in Hutchinson County. Areas are long and narrow and range from 5 to 35 acres in size. Slopes are short and convex. The mapped areas are about 55 percent Ethan soil, 25 percent Betts soil, and 20 percent other soils. The Ethan soil is on the sides of ridges and knolls and on the tops of some of the wider ridges. The Betts soil is on the upper side slopes and tops of ridges and knolls and is moderately eroded in places. The Betts soil has a lighter colored surface layer than the soil described as representative of the Betts series because of the erosion and mixing of soil layers by plowing.

Included with these soils in mapping are small areas of Bonilla, Clarno, Davison, Hand, and Prosper soils. Bonilla and Prosper soils are in swales. Clarno and Hand soils are on the lower side slopes of some ridges and knolls. Davison soils are on the edge of some swales.

Runoff is medium, and the hazard of erosion is severe. Controlling erosion and improving fertility are the main concerns of management.

Almost all areas are cultivated. These soils are moderately well suited to crops commonly grown in the survey area. Capability unit IIIe–6, pasture group G, windbreak group 8.

EtC2—Ethan-Betts loams, 6 to 9 percent slopes, eroded. These are gently rolling soils on uplands in Hutchinson County. Areas are long and narrow and range from 5 to 25 acres in size. Slopes are short and convex. The areas are about 50 percent Ethan soil, 30 percent Betts soil, and 20 percent other soils. The Ethan soil is on the sides of ridges and knolls, and the Betts soil is on the upper side slopes and tops of ridges and knolls. These soils are moderately to severely eroded. The Ethan soil has the profile described as representative of the series, but in places the surface layer is thinner. The Betts soil has a surface layer that is light brownish gray because it is eroded and because the layers are mixed by plowing.

Included with these soils in mapping are small areas of Clarno, Hand, Prosper, and Tetonka soils. Clarno and Hand soils are on the lower side slopes of ridges and knolls. Prosper soils are in swales. Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is medium to rapid, and the hazard of erosion is very severe. The fertility of these soils has been lowered by erosion. Controlling erosion and improving fertility are the main concerns of management.

All areas are cultivated or have been cultivated. These soils are poorly suited to crops because of low fertility and the very severe hazard of erosion. Capability unit VIe–3, pasture group G, windbreak group 10.

EtD—Ethan-Betts loams, 9 to 15 percent slopes. These soils are on uplands in areas that range from 10 to 50 acres. They are on the sides of entrenched drainageways and on ridges and hills of glacial end moraines. Slopes are short and convex. The mapped areas are about 45 percent Ethan soil, 30 percent Betts soil, and 25 percent other soils. Glacial stones and boulders are on some ridges and hills in areas that range from 1 to 5 acres in size. The Ethan soil is on the middle part of the landscape. The Betts soil is on the upper side slopes and tops of ridges and hills. In areas of native grassland the Ethan soil has a noncalcareous surface layer. In cultivated areas the Betts soil is moderately to severely eroded and has a lighter colored surface layer than is typical of the series.

Included with these soils in mapping are small areas of Chaska, Clarno, Davis, and Prosper soils. Chaska soils are on narrow bottoms of entrenched drainageways. Clarno soils are on the lower side slopes of ridges and hills. Davis soils are on foot slopes, and Prosper soils are in swales.

Runoff is medium to rapid, and the hazard of erosion is very severe. Controlling erosion is the main concern of management.

Most areas remain in native grassland and are used for pasture. Capability unit VIe–3, pasture group G, windbreak group 10.

EuB—Ethan-Clarno loams, 2 to 6 percent slopes. These soils are on slight rises that are separated by narrow swales and small closed depressions on uplands in Hanson County. Areas are irregular in shape and range from 5 to 35 acres in size. Slopes are short and convex. Mapped areas are about 40 percent Ethan soil, 40 percent Clarno soil, and 20 percent other soils. The Ethan soil is on the upper part of rises and is moderately eroded in places. The Clarno soil is on the lower part of rises and has a thinner subsoil than the soil described as representative of the Clarno series.

Included with these soils in mapping are small areas of Bonilla, Crossplain, Davison, Prosper, and Tetonka soils. Bonilla, Crossplain, and Prosper soils are in swales. Davison soils are on the edge of swales. Tetonka soils are in closed depressions, some of which

are shown on the soil map by the symbol for a wet spot.

Runoff is medium, and the hazard of erosion is moderate to severe. Eroded areas of the Ethan soil are low in fertility. Controlling erosion and improving fertility are the main concerns of management.

Most areas are used as cropland. These soils are moderately well suited to well suited to most crops grown in the survey area. Ethan soil is in capability unit IIIe–6, pasture group G, windbreak group 8; Clarno soil is in capability unit IIe–2, pasture group F, windbreak group 3.

EuC—Ethan-Clarno loams, 6 to 9 percent slopes. These are gently rolling soils on uplands in Hanson County. They are on ridges and knolls that are separated by swales and small closed depressions. Slopes are short and convex. Areas are long and narrow and range from 5 to 85 acres. Mapped areas are about 45 percent Ethan soil, 40 percent Clarno soil, and 15 percent other soils.

The Ethan soil is in the higher areas of the landscape and is moderately eroded in places. The Clarno soil has a thinner subsoil than the soil described as representative of the Clarno series.

Included with these soils in mapping are small areas of Betts, Bonilla, Crossplain, Prosper, and Tetonka soils. Betts soils are on the tops of some narrow ridges and commonly are moderately to severely eroded. Bonilla, Crossplain, and Prosper soils are in swales. Tetonka soils are in closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is medium. The hazard of erosion is severe, and eroded areas have low fertility. Controlling erosion and improving fertility are the main concerns of management.

Most areas are cultivated. These soils are moderately well suited to most crops; they are better suited to close-sown small grain crops than to row crops because of the hazard of erosion. Ethan soil is in capability unit IVe–2, pasture group G, windbreak group 8; Clarno soil is in capability unit IIIe–1, pasture group F, windbreak group 3.

EwC—Ethan-Homme complex, 6 to 9 percent slopes. This complex consists of gently rolling soils on uplands in Hutchinson County. These soils are on ridges and knolls that are separated by swales and small closed depressions in places. Areas are long and narrow and range from 5 to 85 acres in size. Mapped areas are about 50 percent Ethan soil, 30 percent Homme soil, and 20 percent other soils.

The Ethan soil has a surface layer of loam and is on the higher part of the landscape where slopes are short and convex. The Homme soil has a surface layer of silty clay loam and is on the lower side slopes of ridges and knolls. The surface layer and subsoil of the Homme soil are thinner than is typical of the Homme series.

Included with these soils in mapping are small areas of Betts, Clarno, Onita, and Tetonka soils. Betts soils are on the tops of some ridges and knolls and commonly are moderately eroded. Clarno soils are on the middle part of the landscape below the Ethan soil; and Onita soils are in swales. Tetonka soils are in closed depressions, some of which are shown on the map by the symbol for a wet spot.

Runoff is medium, and the hazard of erosion is severe. Improving the level of fertility in the Ethan soil and controlling erosion are the main concerns of management.

Most areas are cultivated. The soils are better suited to small grain, alfalfa, and tame grasses than to row crops because of the hazard of erosion. Ethan soil is in capability unit IVe–2, pasture group G, windbreak group 8; Homme soil is in capability unit IIIe–2, pasture group F, windbreak group 3.

Fedora Series

The Fedora series consists of deep, poorly drained, nearly level, calcareous, loamy soils on uplands. These soils formed in glacial melt-water deposits. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is dark gray fine sandy loam about 9 inches thick. Below the surface layer is a transition layer of dark gray fine sandy loam about 4 inches thick. The underlying material, to a depth of 33 inches, is light gray and dark gray fine sandy loam. To a depth of 56 inches, it is light gray and pale yellow silt loam. Pale olive sandy loam is at a depth of 56 inches. All layers are calcareous.

Fedora soils have medium fertility and moderate organic-matter content. Permeability is moderately rapid, and the available water capacity is moderate or high. Early in the growing season the seasonal high water table is at a depth of 1 to 4 feet.

Most areas are cultivated, but a few remain in native grassland and are used for hay and for grazing.

Representative profile of Fedora fine sandy loam, in an area of Fedora soils, in cultivation, 1,103 feet west and 743 feet south of the northeast corner of sec. 25, T. 99 N., R. 59 W.

Ap—0 to 9 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; few fine faint mottles of light olive brown (2.5Y 5/6) moist; weak coarse subangular blocky structure; slightly hard, very friable; strong effervescence; moderately alkaline; abrupt wavy boundary.

AC—9 to 13 inches; dark gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) moist; common medium distinct mottles of dark gray (5Y 4/1) and few fine distinct mottles of light olive brown (2.5Y 5/6) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable; few fine dark segregations of iron and manganese oxides; strong effervescence; moderately alkaline; clear irregular boundary.

C1gca—13 to 21 inches; light gray (5Y 7/1) and dark gray (5Y 4/1) fine sandy loam, gray (5Y 5/1) moist; common fine distinct mottles of pale olive (5Y 6/4) and few fine distinct mottles of light olive brown (2.5Y 5/6) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard,

very friable; many fine segregations of lime; violent effervescence; moderately alkaline; abrupt wavy boundary.

C2g—21 to 33 inches; light gray (5Y 7/2) fine sandy loam, olive gray (5Y 5/2) moist; many coarse prominent mottles of light olive brown (2.5Y 5/6) and few fine distinct mottles of brown (7.5Y 5/4) moist; weak coarse subangular blocky structure; slightly hard, very friable; many coarse dark segregations of iron and manganese oxides; few fine segregations of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C3g—33 to 48 inches; light gray (5Y 7/2) silt loam, gray (5Y 5/1) moist; many coarse prominent mottles of light olive brown (2.5Y 5/6) and common fine distinct mottles of brown (7.5Y 5/4) moist; massive; slightly hard, very friable, slightly sticky; common medium dark segregations of iron and manganese oxides; few fine segregations of lime; strong effervescence; moderately alkaline; clear smooth boundary.

C4g—48 to 56 inches; light gray (5Y 7/1) and pale yellow (5Y 7/3) silt loam, gray (5Y 5/1, 6/1) moist; many coarse prominent mottles of light olive brown (2.5Y 5/6) and brown (7.5YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium dark segregations of iron and manganese oxides; few fine segregations of lime; strong effervescence; mildly alkaline; clear wavy boundary.

C5g—56 to 60 inches; pale olive (5Y 6/4) sandy loam, olive brown (2.5Y 4/4) moist; many coarse distinct mottles of light olive brown (2.5Y 5/6) and few fine distinct mottles of brown (7.5YR 5/4) moist; massive; soft, very friable; few fine dark segregations of iron and manganese oxides; strong effervescence; mildly alkaline.

The solum is 6 to 16 inches thick. Free carbonates are within 6 inches of the surface. Reaction is mildly alkaline or moderately alkaline in the A horizon and moderately alkaline or strongly alkaline in the AC horizon and upper part of the C horizon. The A horizon is very dark gray or dark gray in hue of 10YR to 5Y or neutral. It ranges from sandy loam to very fine sandy loam and is 6 to 10 inches thick. Some profiles lack an AC horizon, but where present it is dark gray to light olive gray in hue of 10YR to 5Y. It ranges from loamy sand to fine sandy loam. The C1 horizon has a calcium carbonate equivalent of 15 to 40 percent. The C horizon is gray or light gray and commonly is stratified with finer or coarser material, but the texture generally is fine sandy loam or sandy loam to a depth of 40 inches. Some profiles have a IIC horizon of gravelly sand below a depth of 40 inches.

Fedora soils are near the Henkin soils and are similar to Davison and Harps soils. They contain more sand than the Davison and Harps soils and are more poorly drained than the Davison and Henkin soils. Fedora soils are also more calcareous than the Henkin soils.

Fa—Fedora soils. These soils are in low areas on uplands in Hutchinson County. Slopes are 0 to 3 percent. The soils are mostly nearly level, but they are gently undulating on the very slight rises between poorly defined drainageways. The surface layer is fine sandy loam in some mapped areas, and in other areas it is sandy loam, very fine sandy loam, loam, or silt loam.

Included with these soils in mapping are small areas of Henkin soils on some of the well drained, higher rises. Also included, in some low areas along drainageways, is a poorly drained loamy sand that lacks lime in the upper 15 inches.

Runoff is slow. Fieldwork commonly is delayed in the spring because of wetness caused by a seasonal high water table. The high lime content in these soils affects crop growth and causes the soils to blow easily. Controlling wetness, improving fertility, and controlling soil blowing are concerns of management.

Most areas are cultivated, but a few remain in native grassland and are used for hay and pasture. Capability unit IIIw–4, pasture group A, windbreak group 2.

Hand Series

The Hand series consists of deep, well drained, nearly level to gently rolling, loamy soils on uplands. These soils formed in stratified glacial melt-water deposits. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark grayish brown loam about 9 inches thick (fig. 8). The subsoil, about 22 inches thick, is loam. It is grayish brown in the upper part and light gray in the lower part. The lower part of the subsoil is calcareous and has spots of soft lime. The underlying material is light yellowish brown and light gray, calcareous silt loam and loam.

Hand soils have medium fertility and moderate organic-matter content. Permeability is moderate, and the available water capacity is high.

Most areas are used for crops, but a few remain in native grassland and are used for grazing and for hay.

Representative profile of Hand loam, 0 to 3 percent slopes, in cultivation, 1,283 feet south and 450 feet east of the northwest corner of sec. 18, T. 100 N., R. 58 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, very friable; medium acid; abrupt smooth boundary.

B2—9 to 17 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable; neutral; abrupt wavy boundary.

B31ca—17 to 24 inches; light gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/3) moist;

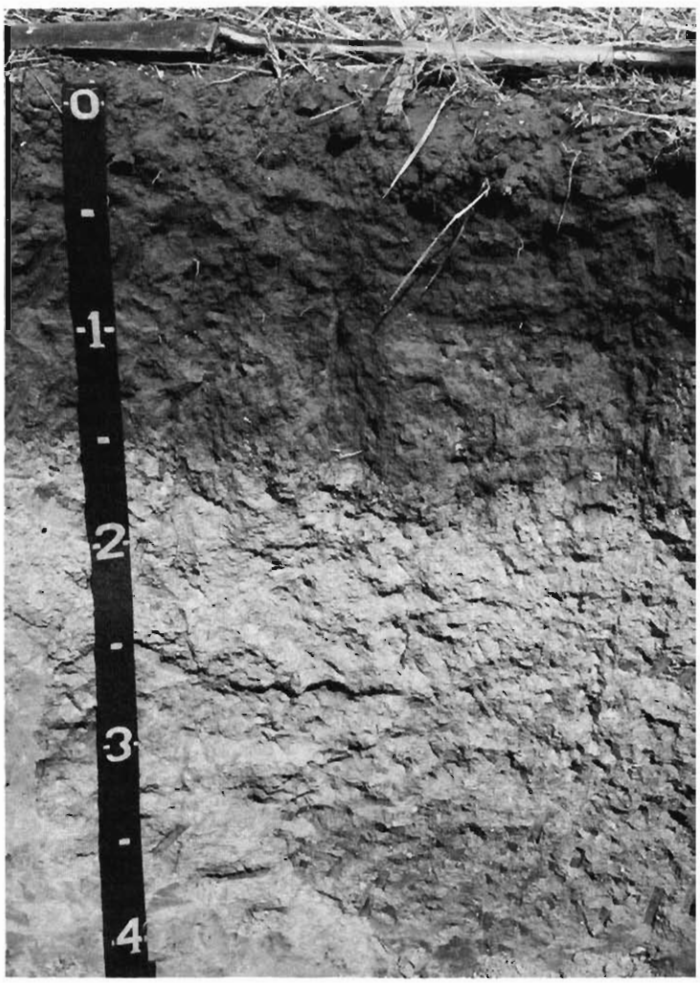

Figure 8.—**Profile of Hand loam, 0 to 3 percent slopes.**

weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, friable; common medium masses and fine threads of segregated lime; strong effervescence; moderately alkaline; gradual wavy boundary.

B32ca—24 to 31 inches; light gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/3) moist; weak coarse and medium prismatic structure parting to weak coarse subangular blocky; hard, very friable; common medium masses and fine threads of segregated lime; strong effervescence; moderately alkaline; clear wavy boundary.

C1—31 to 40 inches; light yellowish brown (2.5Y 6/4) silt loam, olive brown (2.5Y 4/4) moist; common fine and medium distinct mottles of gray (2.5Y 6/1) and olive yellow (2.5Y 6/6) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline; clear smooth boundary.

C2—40 to 52 inches; light yellowish brown (2.5Y 6/4) and light gray (2.5Y 7/1) silt loam, olive brown (2.5Y 4/4) and gray (2.5Y 5/1) moist; many medium distinct mottles of olive yellow (2.5Y 6/6) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline; clear wavy boundary.

C3—52 to 60 inches; light yellowish brown (2.5Y 6/4) and light gray (2.5Y 7/1) loam, olive brown (2.5Y 4/4) and gray (2.5Y 5/1) moist; many medium and fine distinct mottles of olive yellow (2.5Y 6/6) and yellowish brown (10YR 5/6) moist; massive; hard, friable; thin dark coatings of iron and manganese oxides on horizontal cleavage planes; strong effervescence; mildly alkaline.

The solum is 20 to 38 inches thick. Depth to free carbonates is 12 to 26 inches. The A horizon is dark gray or dark grayish brown and is medium acid to neutral. It is 6 to 10 inches thick. The B2 horizon is dark grayish brown to light olive brown in hue of 10YR or 2.5Y and is loam or light clay loam. It is slightly acid or neutral and is 6 to 10 inches thick. The B3 horizon is light brownish gray to pale yellow. In places it is light clay loam or silty clay loam. The C horizon is gray to pale yellow in hue of 2.5Y or 5Y. It commonly is stratified silt loam, loam, and fine sandy loam, but in places it contains layers as coarse as loamy sand.

Hand soils are mapped with the Bonilla and Davison soils and are near the Clarno and Ethan soils. When moist, they have dark colors nearer to the surface than the Bonilla soils. Hand soils are more stratified in texture in the C horizon than the Clarno and Ethan soils, and they are deeper to lime than the Davison soils.

HaA—Hand loam, 0 to 3 percent slopes. This nearly level to gently undulating soil is on uplands. Areas are irregular in shape and range from 5 to 100 acres in size. Mapped areas consist of very slight rises that are broken by shallow swales or poorly defined drainageways and by small closed depressions. This soil has the profile described as representative of the series, but in places the lower part of the subsoil is silt loam.

Included with this soil in mapping are small areas of Bonilla, Davison, Henkin, and Tetonka soils. The Bonilla soils are in swales. The Davison and Henkin soils are on some of the rises. The Tetonka soils are in closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is slow. The hazard of erosion is slight. This soil has few or no limitations to use for crops. Maintaining fertility is the main concern of management.

Most areas are cultivated. This soil is well suited to all crops commonly grown in the survey area. Capability unit I–2, pasture group F, windbreak group 3.

HaB—Hand loam, 3 to 6 percent slopes. This undulating soil is on uplands. Areas are irregular in shape and range from 5 to 75 acres in size. Slopes are short and convex. This soil contains more sand and less silt in the underlying material than the soil described as representative of the series.

Included with this soil in mapping are small areas of Bonilla, Davison, Henkin, and Tetonka soils. The Bonilla soils are on foot slopes and in swales. The

Davison and Henkin soils are on some of the rises. The Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is medium. The hazard of water erosion is moderate. Controlling erosion is the main concern of management.

Most areas are cultivated. This soil is well suited to all crops commonly grown in the survey area. Capability unit IIe–2, pasture group F, windbreak group 3.

HaC—Hand loam, 6 to 9 percent slopes. This gently rolling soil is on upland ridges and knolls. Areas range from 5 to 60 acres in size. Slopes are short and convex. The Hand soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are small areas of Betts, Bonilla, Davison, Ethan, and Henkin soils. The Betts and Ethan soils are on foot slopes and in swales. The Davison and Henkin soils are on some of the rises.

Runoff is medium, and the hazard of erosion is severe. Controlling erosion is the main concern of management.

Most areas are cultivated. These soils are well suited to all crops commonly grown in the survey area. Capability unit IIIe–1, pasture group F, windbreak group 3.

HbC—Hand-Betts loams, 6 to 9 percent slopes. These are gently rolling soils on uplands in Hutchinson County. Areas are long and narrow and range from 5 to 30 acres in size. Slopes are short and convex. Mapped areas are about 60 percent Hand soil, 25 percent Betts soil, and 15 percent other soils. The Hand soil is on the sides of ridges and knolls. The Betts soil is on the top and upper side slopes of ridges and knolls. In places it is moderately eroded. The Hand soil has a thinner layer and subsoil than the soil described as representative of the series. In cultivated fields the Betts soil has a lighter colored surface layer than the soil described as representative of the Betts series because of erosion and mixing of the soil layers by plowing.

Included with these soils in mapping are small areas of Bonilla, Ethan, and Henkin soils. The Bonilla soils are in ridge saddles and swales and on foot slopes. The Ethan soils are on the upper side slopes of some of the ridges and knolls. The Henkin soils are intermingled with the Hand soil in some areas.

Runoff is medium. The hazard of erosion is severe. Improving the fertility level of the Betts soil and controlling erosion are the main concerns of management.

Most areas are cultivated. The Hand soil is well suited to all crops commonly grown in the survey area, but crop growth is limited on the Betts soil because of low fertility. Hand soil is in capability unit IIIe–1, pasture group F, windbreak group 3; Betts soil is in capability unit IVe–2, pasture group G, windbreak group 8.

HcA—Hand-Bonilla loams, 0 to 3 percent slopes. These are nearly level to gently undulating soils on uplands in Hutchinson County. The areas, which are irregular in shape and range from 10 to 120 acres in size, consist of many low convex rises interspersed with shallow swales and a few closed depressions. They are about 60 percent Hand soil, 25 percent Bonilla soil, and 15 percent other soils. The Hand soil is on the low rises, and in a few places it has a more silty B horizon than the soil described as representative of the series. Also, in T. 98 N., R. 56 W., the Hand soil is deeper to lime than is typical for the series. The Bonilla soil is in shallow swales.

Included with these soils in mapping are small areas of Davison, Henkin, and Tetonka soils. The Davison soils are on the edge of the shallow swales and on some of the rises. The Henkin soils are on some of the rises. The Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is slow and collects on the Bonilla part of the mapped areas. The hazard of erosion is slight. During wet years, the Bonilla soil is subject to flooding for very brief periods and has a seasonal high water table. In most years these soils have few or no limitations for crop use.

Most areas are cultivated. These soils are well suited to all crops commonly grown in Hutchinson County. Capability unit I–2; Hand soil is in pasture group F, windbreak group 3; Bonilla soil is in pasture group K, windbreak group 1.

HdB—Hand-Davison loams, 3 to 6 percent slopes. These are undulating soils on uplands in long and narrow areas that range from 5 to 50 acres in size. The short slopes are mostly convex, but some are concave. Mapped areas consist of slight rises broken by narrow swales and closed depressions. They are about 65 percent Hand soil, 25 percent Davison soil, and 10 percent other soils. The Hand soil is on the rises, and in places it has a more silty subsoil than is typical of the series. The Davison soil is on the edge of swales and rises. In places it is moderately eroded.

Included with these soils in mapping are small areas of Bonilla, Crossplain, Henkin, and Tetonka soils. The Bonilla and Crossplain soils are in swales. The Henkin soils are intermingled with the Hand soil on some of the rises. The Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is medium. The hazard of erosion is moderate. The high lime content of the Davison soil affects crop growth and causes the soil to blow easily. Improving the fertility of the Davison soil and controlling erosion and soil blowing are the main concerns of management.

Most areas are cultivated. These soils are well suited to moderately well suited to all crops grown in the survey area. Pasture group F; Hand soil is in capability unit IIe–2, windbreak group 3; Davison soil is in capability unit IIIe–8, windbreak group 1.

Harps Series

The Harps series consists of deep, poorly drained, nearly level, calcareous, loamy soils on uplands. These soils formed in glacial till. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is dark gray loam about 10 inches thick. The underlying material is light brownish gray loam to a depth of 26 inches and light gray loam below that. It contains

spots and streaks of soft lime and gypsum. The soil material is calcareous throughout.

Harps soils have medium fertility and moderate organic-matter content. Permeability is moderate, and the available water capacity is high. These soils have a seasonal high water table at a depth of 1 to 3 feet early in the growing season, but in dry years it remains below a depth of 5 feet.

Most areas are cultivated, but a few remain in native grassland and are used for hay and for grazing.

Harps soils in this survey area are mapped only with the Crossplain and Tetonka soils.

Representative profile of Harps loam in an area of Tetonka-Harps complex, in native grass, 1,447 feet west and 425 feet south of the northeast corner of sec. 8, T. 98 N., R. 58 W.

A1—0 to 10 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; few fine and medium distinct mottles of brownish yellow (10YR 6/6) moist; weak medium subangular blocky structure parting to weak medium and fine granular; hard, friable; slight effervescence; neutral; clear irregular boundary.

C1ca—10 to 19 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; common medium distinct mottles of brownish yellow (10YR 6/6) moist; weak coarse subangular blocky structure parting to weak medium subangular blocky; hard, friable, slightly sticky; tongues (1 to 2 inches wide) of very dark grayish brown (10YR 3/2) moist in the upper 3 inches; many medium segregations of lime; violent effervescence; mildly alkaline; gradual wavy boundary.

C2ca—19 to 26 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; many medium distinct mottles of brownish yellow (10YR 6/6) moist; weak coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine dark segregations of iron and manganese oxides; common fine nests of gypsum; common medium segregations of lime; violent effervescence; mildly alkaline; gradual wavy boundary.

C3gcs—26 to 39 inches; light gray (5Y 7/1) loam, gray (5Y 6/1) moist; many coarse prominent mottles of brownish yellow (10YR 6/6) moist; weak coarse subangular blocky structure; hard, friable, slightly sticky; common fine dark segregations of iron and manganese oxides; many coarse nests of gypsum crystals; few medium segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C4gcs—39 to 60 inches; light gray (5Y 7/1) heavy loam, gray (5Y 6/1) moist; many coarse prominent mottles of light yellowish brown (2.5Y 6/6) moist; massive; hard, friable, slightly sticky and slightly plastic; common fine dark segregations of iron and manganese oxides; many coarse nests of gypsum crystals; few medium segregations of lime; strong effervescence; mildly alkaline.

Free carbonates are at or within 6 inches of the surface. Horizons that have a calcium carbonate equivalent of 15 percent or more are within 16 inches of the surface. All horizons are loam or light clay loam. The A horizon is very dark gray to gray and is neutral to moderately alkaline. It is 10 to 15 inches thick. Some profiles have an AC horizon up to 7 inches thick. The C horizon is gray to light gray. Some profiles lack nests of gypsum crystals in the C horizon.

Harps soils are mapped with the Crossplain and Tetonka soils and are similar to the Davison and Fedora soils. They contain less clay and are calcareous at a shallower depth than the Crossplain and Tetonka soils. Harps soils are more poorly drained than the Davison soils and contain more clay and less sand than the Fedora soils.

Henkin Series

The Henkin series consists of deep, well drained, nearly level to undulating, loamy soils on uplands. These soils formed in glacial melt-water deposits. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark grayish brown fine sandy loam about 8 inches thick. The subsoil, about 26 inches thick, is fine sandy loam. It is dark grayish brown in the upper part, dark brown and brown in the middle part, and light yellowish brown in the lower part. The underlying material is calcareous, stratified fine sand and fine sandy loam.

Henkin soils have medium fertility and moderate organic-matter content. Permeability is moderately rapid, and the available water capacity is moderate or high.

Most areas are used for crops; a few remain in native grassland and are used for grazing and for hay.

Representative profile of Henkin fine sandy loam, 2 to 6 percent slopes, in cultivation, 1,514 feet south and 254 feet east of the northwest corner of sec. 9, T. 102 N., R. 59 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) fine sandy loam, black (10YR 2/1) moist; weak coarse subangular blocky structure; slightly hard, very friable, slightly acid; abrupt smooth boundary.

B21—8 to 14 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable; slightly acid; clear wavy boundary.

B22—14 to 19 inches; dark brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, very friable; neutral; clear wavy boundary.

B23—19 to 26 inches; brown (10YR 5/3) fine

sandy loam, dark grayish brown (10YR 4/2) moist; weak medium and coarse subangular blocky structure; slightly hard, very friable; neutral; clear wavy boundary.

B3—26 to 34 inches; light yellowish brown (2.5Y 6/3) fine sandy loam, olive brown (2.5Y 4/3) moist; weak coarse subangular blocky structure; soft, very friable; neutral; abrupt wavy boundary.

C1—34 to 42 inches; light yellowish brown (2.5Y 6/3) fine sand, olive brown (2.5Y 4/3) moist; single grained; loose; slight effervescence; moderately alkaline; clear irregular boundary.

C2ca—42 to 52 inches; light yellowish brown (2.5Y 6/3) fine sandy loam, olive brown (2.5Y 4/3) moist; massive; slightly hard, very friable; common medium segregations of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C3—52 to 60 inches; light brownish gray (2.5Y 6/2) fine sand, grayish brown (2.5Y 5/2) moist; single grained; loose; slight effervescence; moderately alkaline.

The solum is 22 to 44 inches thick. Depth to free carbonates is 20 to 50 inches. The A horizon is very dark gray to dark grayish brown. In places it is loam. It is 6 to 10 inches thick and is slightly acid or neutral. The B2 horizon is dark grayish brown to light olive brown in hue of 10YR or 2.5Y and is fine sandy loam, sandy loam, or light loam. It is 9 to 22 inches thick. The B3 and C horizons are grayish brown to pale yellow in hue of 10YR or 2.5Y. In places, the B3 horizon is calcareous. The C horizon is stratified with textures ranging from fine sand to loam. It is neutral to moderately alkaline.

Henkin soils contain more sand and less clay in the B horizon than the nearby Clarno, Delmont, Enet, and Hand soils. They also have a less gravelly C horizon than the Delmont and Enet soils.

HmA—Henkin fine sandy loam, 0 to 2 percent slopes. This soil is on uplands in Hanson County. Areas are irregular in shape and range from 5 to 45 acres in size. Slopes are mostly nearly level, but the very slight rises are broken by slightly depressed swales or poorly defined drainageways. In a few places the surface layer is loam.

Included with this soil in mapping are small areas of Delmont and Hand soils and the Henkin variant. The Delmont and Hand soils are on some of the low rises. The Henkin variant is on some of the low parts of the landscape.

Runoff is slow. This soil is somewhat droughty and is moderately susceptible to soil blowing. Controlling soil blowing and conserving moisture are the main concerns of management.

Most areas are cultivated. This soil is moderately well suited to most crops grown in the survey area. Small grain, sorghum, and tame grasses are better suited than corn during periods of drought. Capability unit IIIs–1, pasture group H, windbreak group 5.

HmB—Henkin fine sandy loam, 2 to 6 percent slopes. This is an undulating soil on uplands. Areas are irregular in shape and range from 5 to 120 acres in size. Slopes are short and convex. This soil has the profile described as representative of the series except that in a few places the surface layer is loam.

Included with this soil in mapping are small areas of Fedora and Hand soils. The Fedora soils are in the low part of the landscape adjacent to drainageways. The Hand soils are on the rises intermingled with the Henkin soils.

Runoff is medium. This soil is somewhat droughty, and the hazards of erosion and soil blowing are moderate. Controlling erosion and soil blowing and conserving moisture are the main concerns of management.

Most areas are cultivated. This soil is moderately well suited to most crops grown in the survey area. Small grain, sorghum, and tame grasses are better suited than corn during periods of drought. Capability unit IIIe–7, pasture group H, windbreak group 5.

Henkin Variant

The Henkin variant consists of well drained, nearly level to undulating soils on upland terraces. These soils are moderately deep over gravel and sand. They formed in glacial melt-water deposits. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark gray fine sandy loam about 9 inches thick. The subsoil, about 17 inches thick, is dark grayish brown sandy loam in the upper 14 inches and grayish brown calcareous gravelly loamy sand in the lower 3 inches. The underlying material is calcareous gravel and sand.

The Henkin variant has a medium level of fertility and moderate organic-matter content. Permeability is moderately rapid in the subsoil and rapid in the underlying gravel and sand. The available water capacity is low.

Many areas are cultivated; some remain in native grassland and are used for grazing.

Representative profile of Henkin variant fine sandy loam, 0 to 6 percent slopes, in cultivation, 1,495 feet north and 900 feet west of the southeast corner of sec. 7, T. 100 N., R. 60 W.

Ap—0 to 9 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak coarse subangular blocky structure; slightly hard, very friable; slightly acid; abrupt smooth boundary.

B21—9 to 15 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; weak medium and coarse prismatic structure; soft, very friable; slightly acid; clear wavy boundary.

B22—15 to 23 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse and medium subangular blocky structure; soft, very friable; slightly acid; clear wavy boundary.

IIB3—23 to 26 inches; grayish brown (10YR 5/2) gravelly loamy sand, dark grayish brown (10YR 4/2) moist; weak medium sub-

angular blocky structure; soft, loose; slight effervescence; neutral; clear wavy boundary.

IIC1—26 to 42 inches; multicolored medium and fine gravel mixed with medium and coarse sand; single grained; loose; many fine fragments of shale; pebbles coated with lime; strong effervescence; mildly alkaline; gradual irregular boundary.

IIC2—42 to 60 inches; multicolored gravelly coarse sand; single grained; loose; few fine fragments of shale; some pebbles coated with lime; strong effervescence; neutral.

Depth to sand and gravel and to free carbonates is 20 to 40 inches. The A horizon is very dark gray to dark grayish brown. It commonly is fine sandy loam or sandy loam, but in places it is loam. It is slightly acid or neutral and is 7 to 10 inches thick. The B2 horizon is dark grayish brown or grayish brown and is sandy loam or fine sandy loam. It is slightly acid or neutral and is 13 to 26 inches thick. The B3 horizon is gravelly loamy sand or gravelly sandy loam and in places is noncalcareous. The C horizon commonly is stratified sand and gravel but in places is loamy sand or sand. Finer textured material is at a depth of 50 to 60 inches in places.

The Henkin variant is near the Delmont and Henkin soils and is similar to the Dimo and Enet soils. It is deeper to gravelly sand or sand and gravel than the Delmont soils, and contains more sand and less clay in the B horizon than the Dimo and Enet soils. The Henkin variant, when moist, has dark colors to a greater depth and has a more gravelly C horizon than the Henkin soils.

HnB—Henkin variant fine sandy loam, 0 to 6 percent slopes. This is a nearly level to undulating soil on upland terraces. Areas range from 5 to 70 acres in size. Slopes generally are short and convex. In a few places the surface layer is loam.

Included with this soil in mapping are small areas of Delmont and Henkin soils on the higher part of convex rises.

Runoff is slow. The hazard of soil blowing is severe, and the soil is droughty. Controlling soil blowing and conserving moisture are the main concerns of management.

Many areas are cultivated. This soil is poorly suited to deep-rooted crops such as corn and alfalfa. It is best suited to spring-sown small grain and tame grasses or to native pasture. In places this soil is a good source of gravel for construction use. Capability unit IVe–3, pasture group D, windbreak group 6.

Homme Series

The Homme series consists of deep, well drained, nearly level to moderately sloping, silty soils on uplands. These soils formed in silty glacial drift. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark grayish brown silty clay loam about 9 inches thick. The subsoil, about 27 inches thick, is brown and light olive brown silty clay loam in the upper part and light yellowish brown calcareous silt loam in the lower part. The lower part of the subsoil has spots and streaks of soft lime that extend into the underlying material. The underlying material is light yellowish brown calcareous loam.

Homme soils have medium fertility and moderate organic-matter content. Permeability is moderately slow, and the available water capacity is high.

Most areas are used for crops, and a few remain in native grassland and are used for hay and for grazing.

Representative profile of Homme silty clay loam in an area of Homme-Onita complex, 2 to 6 percent slopes, in cultivation, 860 feet north and 845 feet west of the southeast corner of sec. 35, T. 97 N., R. 61 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak fine granular structure; very hard, friable, sticky and plastic; slightly acid; abrupt smooth boundary.

B21—9 to 15 inches; brown (10YR 5/3) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to moderate and strong medium and fine blocky; hard, firm, sticky and plastic; slightly acid; clear wavy boundary.

B22—15 to 19 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; weak medium prismatic structure parting to moderate and strong medium and fine blocky; hard, firm, sticky and plastic; coatings of dark brown (10YR 4/3) moist on faces of peds; mildly alkaline; clear wavy boundary.

B23—19 to 24 inches; light olive brown (2.5Y 5/3) silty clay loam, olive brown (2.5Y 4/3) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; dark grayish brown (2.5Y 4/2), moist, coatings on faces of peds; mildly alkaline; clear wavy boundary.

B31ca—24 to 27 inches; light yellowish brown (2.5Y 6/3) silt loam, olive brown (2.5Y 4/3) moist; moderate medium prismatic structure parting to moderate medium and coarse subangular blocky; hard, friable, slightly sticky and slightly plastic; few medium segregations of lime; strong effervescence; mildly alkaline; clear wavy boundary.

B32ca—27 to 36 inches; light yellowish brown (2.5Y 6/3) silt loam, olive brown (2.5Y 4/3) moist; many medium distinct and prominent mottles of olive yellow (2.5Y 6/6) and yellowish brown (10YR 5/6) moist; moderate medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many medium segregations of lime; strong effervescence; mildly alkaline; clear wavy boundary.

IIC1ca—36 to 50 inches; light yellowish brown (2.5Y 6/3) loam, olive brown (2.5Y 4/4) moist; many medium distinct and prominent mottles of olive yellow (2.5Y 6/6), yellowish brown (10YR 5/6), and gray (2.5Y 6/1) moist; massive; hard, friable, slightly sticky; few fine dark segregations of iron and manganese oxides; many medium segregations of lime; strong effervescence; mildly alkaline; diffuse wavy boundary.

IIC2ca—50 to 60 inches; light yellowish brown (2.5Y 6/3) and gray (2.5Y 6/1) clay loam, olive brown (2.5Y 4/4) moist; many medium distinct mottles of olive yellow (2.5Y 6/6) and yellowish brown (10YR 5/6) moist; massive; hard, friable, slightly sticky and slightly plastic; common fine and medium dark segregations of iron and manganese oxides; common medium segregations of lime; strong effervescence; mildly alkaline.

The solum is 25 to 45 inches thick. Depth to loam or clay loam glacial drift commonly is 30 to 40 inches but ranges from 25 to 60 inches. Depth to free carbonates is 15 to 34 inches. The A horizon is very dark gray to dark grayish brown and is silty clay loam or heavy silt loam. It is slightly acid or neutral and is 7 to 10 inches thick. The B2 horizon is dark grayish brown to light olive brown and is 8 to 20 inches thick. The B3 horizon is grayish brown to light yellowish brown in hue of 10YR or 2.5Y. In places it is silty clay loam, loam, or clay loam. The C horizon is gray to pale yellow in hue of 10YR or 2.5Y. In places, the C horizon is silt loam or silty clay loam that is stratified with lenses of sandy loam and very fine sandy loam. The B3 and C horizons are mildly alkaline or moderately alkaline.

Homme soils are mapped with the Ethan and Onita soils. They are more silty and are deeper to lime than the Ethan soils, and they are better drained and have a less clayey B horizon than the Onita soils.

HoC—Homme-Ethan complex, 6 to 9 percent slopes. These are moderately sloping soils on uplands in Hutchinson County. Areas range from 5 to 70 acres in size. This complex consists of about 60 percent Homme soil, 25 percent Ethan soil, and 15 percent other soils. The Homme soil is on the sides of ridges and knolls and has long, smooth slopes. The Ethan soil is on the top and upper side slopes of the ridges and knolls and has short, convex slopes. The Homme soil has a surface layer of silty clay loam. The surface layer and the subsoil are thinner than is typical of the series. This Ethan soil has a loam surface layer.

Included with these soils in mapping are small areas of Betts, Clarno, Onita, Tetonka, and Whitewood soils. The Betts soils are on the top of some of the ridges and commonly are moderately eroded. The Clarno soils in most places are immediately below the Ethan soil. The Onita and Whitewood soils are on foot slopes and along drainageways. The Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is medium. The hazard of erosion is severe. In places erosion has lowered the fertility of the Ethan soil. Improving the fertility of the Ethan soil and controlling erosion are the main concerns of management.

Most areas are cultivated. These soils are moderately well suited to all crops grown in the survey area. Homme soil is in capability unit IIIe–2, pasture group F, windbreak group 3; Ethan soil is in capability unit IVe–2, pasture group G, windbreak group 8.

HtA—Homme-Onita complex, 0 to 2 percent slopes. These are nearly level soils on uplands in Hutchinson County. Areas are irregular in shape and range from 5 to 130 acres in size. The soils are on broad flats that have shallow swales or poorly defined drainageways and a few small closed depressions. The mapped areas are about 60 percent Homme soil, 25 percent Onita soil, and 15 percent other soils. The Homme soil is on the very slight rises of the flats and has a surface layer of silty clay loam. The Onita soil is in the slightly concave low part of the landscape and has a surface layer of silt loam.

Included with these soils in mapping are small areas of Tetonka and Whitewood soils. The Tetonka soils are in closed depressions, some of which are shown on the maps by the symbol for a wet spot. The Whitewood soils are along some of the drainageways.

Runoff is slow. These soils have few or no limitations for crops. Fieldwork, however, is delayed in wet years because the Onita soil is subject to flooding for very brief periods and has a seasonal high water table. In most years, the additional moisture on the Onita soil is beneficial. Maintaining fertility and tilth is the main concern of management.

Almost all areas are cultivated. These soils are well suited to all crops grown in the survey area. Capability unit I–2; Homme soil is in pasture group F, windbreak group 3; Onita soil is in pasture group K, windbreak group 1.

HtB—Homme-Onita complex, 2 to 6 percent slopes. These are gently sloping soils on uplands in Hutchinson County. This complex consists of about 60 percent Homme soil, 25 percent Onita soil, and 15 percent other soils. The Homme soil is on slight rises and has long smooth slopes that are plane to slightly convex. The Onita soil is on foot slopes and in swales where slopes are slightly concave. This Homme soil has a surface layer of silty clay loam and has the profile described as representative of the series. This Onita soil has a surface layer of silt loam.

Included with these soils in mapping are small areas of Davison, Ethan, Tetonka, and Whitewood soils. The Davison soils are on rises bordering swales and depressions. The Ethan soils are on the top of some of the ridges. The Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot. The Whitewood soils are in some of the swales or along drainageways.

Runoff is medium. The hazard of erosion is moderate. Controlling erosion is the main concern of management.

Most areas are cultivated. These soils are well suited to all crops grown in the survey area. Capability unit IIe–3; Homme soil is in pasture group F, windbreak group 3; Onita soil is in pasture group K, windbreak group 1.

James Series

The James series consists of deep, poorly drained and very poorly drained, nearly level, calcareous soils on bottom lands. These soils formed in clayey alluvium. The native vegetation consisted mainly of tall and mid grasses that are tolerant to excess water and salt.

In a representative profile the surface layer is very dark gray silty clay about 10 inches thick. The subsoil, about 10 inches thick, is dark gray silty clay. The underlying material is dark gray silty clay. There are spots and streaks of salt throughout the upper 40 inches of the profile, and all layers are calcareous.

James soils have medium fertility and high organic-matter content. Permeability is slow or very slow, and the available water capacity is moderate or high. These soils are frequently flooded by stream overflow, and the water table is above a depth of 2 feet early in the growing season.

Most areas remain in native vegetation and are used for hay or pasture. A few of these less poorly drained areas are used for crops.

Representative profile of James silty clay, in native grass, 1,100 feet west and 620 feet north of the southeast corner of sec. 18, T. 101 N., R. 58 W.

A11sa—0 to 1 inch; very dark gray (2.5Y 3/1) silty clay, black (2.5Y 2/1) moist; weak fine granular structure; slightly hard, firm, sticky and plastic; common fine white (2.5Y 8/1) spots of salts; slight effervescence; mildly alkaline; clear smooth boundary.

A12gsa—1 to 10 inches; very dark gray (2.5Y 3/1) silty clay, black (N 2/0) moist; weak medium subangular structure parting to weak fine subangular blocky; very hard, firm, sticky and plastic; many fine and medium threads and spots of salts; strong effervescence; moderately alkaline; clear smooth boundary.

B2gsa—10 to 20 inches; dark gray (2.5Y 4/1) silty clay, very dark gray (N 3/0) moist; weak medium and coarse subangular blocky structure parting to moderate very fine and fine subangular blocky; very hard, firm, sticky and plastic; many fine threads and spots of salt; strong effervescence; strongly alkaline; clear wavy boundary.

A11bg—20 to 40 inches; dark gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; very hard, very firm, sticky and plastic; common fine spots and threads of salts; common medium nests of gypsum; slight effervescence; moderately alkaline; gradual wavy boundary.

A12bg—40 to 54 inches; dark gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) moist; massive; very hard, very firm, sticky and plastic; many coarse nests of gypsum; few medium segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

Cgcacs—54 to 60 inches; dark gray (2.5Y 4/1) silty clay, very dark gray (N 3/0) moist; massive; very hard, very firm, sticky and plastic; many coarse nests of gypsum; many coarse segregations of lime; strong effervescence; moderately alkaline.

The solum is 26 to 58 inches thick. Free carbonates are within 10 inches of the surface. Texture, to a depth of 40 inches or more, is heavy silty clay loam, silty clay, or clay. Electrical conductivity of the A and B horizons ranges from 4 to 20 millimhos. Colors throughout the profile are in hue of 2.5Y or 5Y or are neutral. The A horizon is 8 to 14 inches thick. The B2g horizon is black to dark gray and is moderately alkaline or strongly alkaline. It is 8 to 14 inches thick. Some profiles have a B3 horizon. The Ab horizon is very dark gray to gray and is mildly alkaline to strongly alkaline. The C horizon is dark gray or gray. In places the C horizon and the lower part of the Ab horizon are stratified with lenses of coarser material.

James soils are near the Clamo, Lamo, Salmo, and Wann soils. They contain more salts than the Clamo, Lamo, and Wann soils. They also contain more clay and are more poorly drained than the Lamo and Wann soils. James soils are more clayey than the Salmo soils.

Ja—James silty clay. This is a nearly level soil on bottom lands along the James River. Areas range from 10 to 80 acres in size and include meander scars and partly filled former stream channels. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas of Clamo, Lamo, Salmo, and Wann soils. The Clamo, Lamo, and Wann soils are on slightly higher levels of the bottom lands. The Salmo soils are intermingled with the James soils in some areas.

Runoff is very slow and is ponded in the lower areas. This soil is frequently flooded by stream overflow and by runoff from adjacent soils. Crop growth is affected by a high water table and by the high salt content. In some years the soil is too wet for use as cropland. This soil loses its tilth if farmed when wet. Wetness and the high salt content are major concerns when this soil is used for crops.

Most areas remain in native grassland and are used for hay and pasture. A few areas are used for crops. This soil is better suited to late-planted crops than to spring-sown crops. Capability unit IVw–2, pasture group J, windbreak group 10.

Lamo Series

The Lamo series consists of deep, somewhat poorly drained, nearly level, calcareous, silty soils on bottom lands. These soils formed in alluvium. The native vegetation consisted mainly of tall grasses, but deciduous trees and shrubs were in some areas.

In a representative profile the surface layer is dark gray silty clay loam about 12 inches thick. The next layer is gray silty clay loam about 14 inches thick. The underlying material, to a depth of 45 inches, is stratified gray silty clay loam and grayish brown silt loam. A buried soil of dark gray silty clay is at a depth of 45 inches. All layers are calcareous.

Lamo soils have high fertility and organic-matter

content. Permeability is moderately slow, and the available water capacity is high. These soils are occasionally flooded by stream overflow, and they have a seasonal high water table at a depth of 2 to 6 feet.

Most areas are cultivated; a few remain in native vegetation and are used for hay and for grazing.

Representative profile of Lamo silty clay loam, in native grass, 1,100 feet west and 525 feet north of the southeast corner of sec. 2, T. 97 N., R. 58 W.

A11—0 to 6 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slight effervescence; neutral; clear wavy boundary.

A12—6 to 12 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; few fine faint mottles of yellowish brown (10YR 5/6) moist; weak medium subangular blocky structure parting to weak medium granular; slightly hard, friable, slightly sticky and slightly plastic; slight effervescence; mildly alkaline; clear wavy boundary.

AC1—12 to 18 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; few fine faint mottles of yellowish brown (10YR 5/6) and brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; strong effervescence; mildly alkaline; gradual wavy boundary.

AC2ca—18 to 26 inches; gray (10YR 5/1) silty clay loam, very dark grayish brown (10YR 3/2) moist; many fine distinct mottles of yellowish brown (10YR 5/6) and brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; hard, friable, slightly sticky and slightly plastic; many fine segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C1gca—26 to 32 inches; gray (5Y 5/1) silty clay loam, olive gray (5Y 4/2) moist; many fine distinct mottles of yellowish brown (10YR 5/6) and brown (7.5YR 5/4) moist; weak coarse and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many medium and fine segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C2gca—32 to 39 inches; grayish brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) moist; many fine distinct mottles of strong brown (7.5YR 5/6) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine dark segregations of iron and manganese oxides; many fine segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C3gca—39 to 45 inches; gray (5Y 5/1) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; many fine faint mottles of brownish yellow (10YR 6/6) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many medium and fine segregations of lime; strong effervescence; mildly alkaline; clear wavy boundary.

Ab—45 to 60 inches; dark gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) moist; weak medium and coarse subangular blocky structure; hard, firm, sticky and plastic; few fine nests of gypsum crystals; neutral.

The solum is 24 to 35 inches thick. Free carbonates are within 10 inches of the surface. The A horizon is dark gray or very dark gray in hue of 10YR or 2.5Y and is silty clay loam or silt loam. It is 12 to 20 inches thick. The AC horizon is gray or dark gray in hue of 10YR or 2.5Y. It is silty clay loam or silt loam, and in places it is stratified with thin lenses of coarser material. The C horizon is gray to light olive gray; in places a buried A horizon is in the C horizon. In places, the C horizon is stratified by lenses of finer or coarser material ranging from loamy sand to silty clay.

Lamo soils are near the Clamo, Salmo, and Wann soils. They contain less clay in the horizons below the A horizon than the Clamo soils and less salts than the Salmo soils. Lamo soils contain less sand and more silt and clay than the Wann soils.

La—Lamo silty clay loam. This is a nearly level soil on bottom lands. Areas are broad and range from 20 to 200 acres in size. Slopes are 0 to 2 percent. In places the uniformity of the slopes is broken by partly filled former stream channels and meander scars. This soil has the profile described as representative of the series, but in a few places a thin layer of silty clay is on the surface.

Included with this soil in mapping are small areas of Clamo, James, Salmo, and Wann soils. The Clamo soils are in some of the lower parts of the landscape. The James and Salmo soils are in some of the former stream channels and small depressed basins. The Wann soils are in places where alluvial sediment is sandy.

Runoff is slow. Fieldwork is delayed in some years by wetness caused by stream flooding and a seasonal high water table. This soil compacts and loses its tilth if farmed when wet. Wetness is the main concern where this soil is used for crops.

Most areas are cultivated. This soil is well suited to most crops grown in the survey area. In wet years it is better suited to late-seeded crops than to spring-sown small grain. Capability unit IIw–3, pasture group A, windbreak group 2.

Lm—Lamo-Wann complex, frequently flooded. These are nearly level soils on bottom land. Areas consist of narrow strips along the James River and range from 5 to 75 acres in size. Slopes are 0 to 2 percent. This complex is about 45 percent Lamo soil, 30 percent Wann soil, and 25 percent other soils. Surface relief is uneven; scouring and deposition from flooding have

caused a series of low mounds or dunes to rise 2 to 5 feet above the intervening swales or meander scars. The Lamo soil is in the low part of the landscape, and the Wann soil is on the mounds or dunes. This Lamo soil has a surface layer of silty clay loam. The underlying material is more stratified in contrasting textures than in the soil described as representative of the series. The Wann soil has a loam surface layer.

Included with these soils in mapping are small areas of Clamo and Salmo soils in some of the low areas. Also included is a loose loamy sand on the crest of some of the dunes or mounds.

Runoff is slow. These soils frequently are flooded early in the growing season and water ponds in some of the low areas. Wetness is the main concern of management.

Most areas remain in native vegetation and are used for grazing and for wildlife habitat. A few areas have been cleared and leveled for crops. These soils are better suited to late-seeded crops than to spring-sown small grain. Capability unit IVw–2, pasture group B, windbreak group 2.

Marsh

Ma—Marsh. This mapping unit consists of closed depressions that are covered by water during much of the growing season. The areas range from 3 to 75 acres in size. Slopes are 0 to 1 percent. Tall grasses and aquatic plants grow in some areas and are grazed in the summer after the water evaporates. In other areas that are covered by water most of the year, only reeds, rushes, cattails, and other aquatic plants grow (fig. 9). The potential for development of wetland wildlife habitat is good. Not placed in interpretive groups.

Onita Series

The Onita series consists of deep, moderately well drained, nearly level and gently sloping, silty soils in swales on uplands. These soils formed in alluvium that washed from adjacent soils. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is dark grayish brown silt loam about 9 inches thick. The subsoil, about 31 inches thick, is silty clay loam that is dark gray in the upper part and grayish brown in the lower part. The lower part is calcareous. The underlying material is light yellowish brown and gray, calcareous clay loam.

Onita soils have high fertility and organic-matter content. Permeability is moderately slow, and the available water capacity is high. These soils are subject to flooding for very brief periods. Early in the growing season the water table is at a depth of 4 to 6 feet.

Most areas are cultivated. A few remain in native grassland and are used for hay and pasture.

Representative profile of Onita silt loam, 0 to 3 percent slopes, in cultivation, 1,900 feet south and 800 feet east of the northwest corner of sec. 18, T. 97 N., R. 61 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and

Figure 9.—Areas of Marsh in Hanson and Hutchinson Counties support reeds, rushes, cattails, and other aquatic plants. Some areas also support a mixture of tall grasses.

slightly plastic; slightly acid; abrupt smooth boundary.

B21t—9 to 15 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium prismatic structure parting to moderate medium and fine blocky; very hard, firm, sticky and plastic; shiny coats on all faces of peds; slightly acid; clear wavy boundary.

B22t—15 to 22 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; weak medium prismatic structure parting to moderate medium and fine subangular blocky and blocky; very hard, firm, sticky and plastic; shiny coats on all faces of peds; neutral; clear wavy boundary.

B23t—22 to 28 inches; grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; shiny coats on faces of peds; mildly alkaline; abrupt wavy boundary.

B31—28 to 32 inches; grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and slightly plastic; slight effervescence; mildly alkaline; gradual wavy boundary.

B32cs—32 to 40 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, sticky and slightly plastic; few medium dark segregations of iron and manganese oxides; common coarse nests of gypsum crystals; few medium segregations of lime; strong effervescence; mildly alkaline; clear wavy boundary.

IICcacs—40 to 60 inches; light yellowish brown (2.5Y 6/3) and gray (2.5Y 6/1) clay loam, olive brown (2.5Y 4/3) and dark gray (2.5Y 4/1) moist; common fine and medium mottles of olive yellow (2.5Y 6/6) moist; massive; hard, friable, sticky and slightly plastic; few fine fragments of shale; few coarse strong brown (7.5YR 5/6) concretions and few fine dark segregations of iron and manganese oxides; common medium nests of gypsum crystals; many medium segregations and few medium concretions of lime; strong effervescence; moderately alkaline.

The solum is 28 to 49 inches thick. Depth to free carbonates is 25 to 40 inches. The A horizon is very dark gray to dark grayish brown and in places is silty clay loam. It is slightly acid or neutral and is 8 to 12 inches thick. Some profiles have a B1 horizon. The B2t horizon is very dark gray to grayish brown and is silty clay loam or silty clay. It is 12 to 25 inches thick. The B3 horizon and C horizon are grayish brown to light yellowish brown. The C horizon commonly is silty clay loam or clay loam alluvium, but in places it is clay loam glacial till or glacial drift. It is stratified in places by lenses of coarser material ranging from loamy sand to loam. This horizon is mildly alkaline or moderately alkaline.

Onita soils are near Davison, Homme, and Whitewood soils and are similar to the Prosper soils. They are deeper to lime than the Davison soils, and they have dark colors to a greater depth than the Homme soils. They have a more clayey B horizon than Homme, Prosper, and Whitewood soils, and they are better drained than the Whitewood soils.

OaA—Onita silt loam, 0 to 3 percent slopes. This is a nearly level soil in swales on uplands in Hutchinson County. Areas are long and narrow and range from 5 to 20 acres in size. Slopes are slightly concave.

Included with this soil in mapping are small areas of Davison, Homme, Tetonka, and Whitewood soils. The Davison and Homme soils are on the edge of the mapped areas. The Tetonka and Whitewood soils are in the lowest part of the swales.

Runoff is slow. This soil receives runoff from adjacent soils and is subject to flooding for very brief periods. Fieldwork is delayed in some years because of temporary wetness, but in most years the additional moisture is beneficial. This soil compacts if farmed when wet. Maintaining tilth and fertility is the main concern of management.

Most areas are cultivated. This soil is well suited to all crops grown in the survey area. Capability unit I–3, pasture group K, windbreak group 1.

Prosper Series

The Prosper series consists of deep, moderately well drained, nearly level, loamy soils in swales on uplands. These soils formed in alluvium that washed from adjacent soils and in the underlying glacial till. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is dark grayish brown and dark gray loam about 13 inches thick. The subsoil, about 26 inches thick, is dark gray loam in the upper part, light olive brown and grayish brown clay loam in the middle part, and light brownish gray calcareous loam in the lower part. The underlying material is light brownish gray calcareous loam.

Prosper soils have high fertility and organic-matter content. Permeability is moderate in the subsoil and moderately slow in the underlying material. The available water capacity is high. Most areas are subject to flooding by runoff from adjacent soils. Early in the growing season the water table is perched at a depth of 3 to 6 feet.

Most areas are cultivated; a few remain in native grassland and are used for hay and pasture.

Representative profile of Prosper loam, in an area of Prosper-Clarno loams, 0 to 2 percent slopes, in cultivation, 2,332 feet north and 435 feet east of the southwest corner of sec. 5, T. 99 N., R. 60 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak coarse subangular blocky structure parting to weak medium and

fine granular; slightly hard, friable; mildly alkaline; abrupt smooth boundary.

A12—10 to 13 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium prismatic structure parting to weak medium subangular blocky and weak fine granular; hard, friable; mildly alkaline; clear wavy boundary.

B21t—13 to 18 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium prismatic structure parting to weak and moderate fine and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; patchy shiny coats on vertical faces of peds; neutral; clear wavy boundary.

B22t—18 to 25 inches; light olive brown (2.5Y 5/3) clay loam, very dark grayish brown (2.5Y 3/2) moist; weak medium prismatic structure parting to weak and moderate medium and fine subangular blocky; very hard, firm, sticky and plastic; shiny coats on vertical faces of peds; neutral; clear wavy boundary.

B23t—25 to 30 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate coarse and medium prismatic structure parting to moderate medium subangular blocky; very hard, friable, sticky and plastic; shiny coats on vertical faces of peds; mildly alkaline; abrupt wavy boundary.

B3—30 to 39 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; common fine distinct mottles of light olive brown (2.5Y 5/6) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few masses and threads of segregated lime; slight effervescence; moderately alkaline; gradual wavy boundary.

Cca—39 to 60 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; common fine distinct mottles of light olive brown (2.5Y 5/6) moist; massive; hard, friable, slightly sticky and slightly plastic; common fine dark segregations of iron and manganese oxides; few fine nests of gypsum crystals; common masses and threads of segregated lime; strong effervescence; moderately alkaline.

The solum is 25 to 45 inches thick. Depth to free carbonates is 20 to 36 inches. The A horizon is very dark gray to dark grayish brown and is slightly acid to mildly alkaline. It is 7 to 13 inches thick. The B2t horizon is neutral or mildly alkaline and is 13 to 23 inches thick. The B3 and C horizons are grayish brown to pale yellow in hue of 10YR or 2.5Y and are loam or clay loam. These horizons are mildly alkaline or moderately alkaline.

Prosper soils are mapped with Clarno, Crossplain, and Stickney soils; they are similar to Bonilla and Onita soils. They contain slightly more clay in the B horizon than Bonilla soils, and they have dark colored horizons to a greater depth and are more poorly drained than Clarno soils. They have a less clayey B horizon than Crossplain, Onita, and Stickney soils, and they are better drained than Crossplain soils.

PcA—Prosper-Clarno loams, 0 to 2 percent slopes. These are nearly level soils on upland flats. Areas range from 5 to 300 acres in size. Slopes are slightly concave to slightly convex. The areas consist of about 50 percent Prosper soil, 40 percent Clarno soil, and 10 percent other soils. The Prosper soil is in the lower part of the landscape where slopes are plane to slightly concave, and the Clarno soil is on very slight rises. This Prosper soil has the profile described as representative of the series.

Included with these soils in mapping are small areas of Crossplain, Davison, Dudley, Stickney, and Tetonka soils. The Crossplain soils are in low areas along drainageways. The Davison, Dudley, and Stickney soils are on some of the very slight rises above the Prosper soils. The Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is slow and collects on the lower part of the landscape. Fieldwork is delayed for brief periods in some years because of wetness, but in most years limitations for cropping are slight. These soils compact and lose their tilth if farmed when wet. Maintaining tilth and fertility are the main concerns of management.

Most areas are cultivated. These soils are well suited to all crops grown in the survey area. Capability unit I–3; Prosper soil is in pasture group K, windbreak group 1; Clarno soil is in pasture group F, windbreak group 3.

Pr—Prosper-Stickney complex. These are nearly level soils on broad upland flats. Areas range from 10 to 200 acres in size. Slopes are 0 to 2 percent and are slightly concave to slightly convex. Areas consist of about 55 percent Prosper soil, 30 percent Stickney soil, and 15 percent other soils. The Prosper soil is in the lower part of the landscape where slopes are plane to slightly concave, and the Stickney soil is on very slight rises. The Prosper soil has a surface layer of loam, and the Stickney soil has a surface layer of silty clay loam.

Included with these soils in mapping are small areas of Clarno, Crossplain, Davison, and Tetonka soils. The Clarno and Davison soils are on some of the very slight rises. The Clarno soils make up as much as 20 percent of some mapped areas. The Crossplain soils are in low wet areas along poorly defined drainageways. The Tetonka soils are in small closed depressions, some of which are shown on the maps by the symbol for a wet spot.

Runoff is slow and collects on the lower part of the landscape. Fieldwork is delayed for brief periods because of wetness, but in most years the Prosper soil has few or no limitations for cropping. The Stickney soil absorbs water slowly and releases moisture slowly to plants. These soils compact if farmed when wet. Maintenance of fertility and tilth are the main concerns of management, but improving water intake in the Stickney soil also is important.

Most areas are cultivated. The Prosper soil is well suited and the Stickney soil is moderately well suited to all crops grown in the survey area. Prosper soil is in capability unit I–3, pasture group K, windbreak group 1; Stickney soil is in capability unit IIs–1, pasture group E, windbreak group 4.

Ps—Prosper and Crossplain soils. These are nearly level soils on uplands in Hutchinson County. They occur in swales and along shallow depressed drainageways. The areas are long and narrow and range from 3 to 25 acres in size. Slopes are 0 to 2 percent. Some areas are dominantly Prosper soil, and some are dominantly Crossplain soil. In a few areas these soils are intermingled in a complex pattern in different proportions. The Prosper soil has a surface layer of loam, and the Crossplain soil has a surface layer of clay loam.

Included with these soils in mapping are small areas of Clarno, Davison, Tetonka, and Whitewood soils. The Clarno and Davison soils are on the edge of the mapped areas. The Tetonka soils are in some of the low areas. The Whitewood soils are intermingled with the Crossplain soils.

Runoff is slow. These soils are subject to flooding by runoff from adjacent soils. Periods of flooding are brief on the Prosper soil, and in most years the additional moisture is beneficial. Fieldwork is commonly delayed on the Crossplain soil by wetness resulting from flooding and from a seasonal high water table. The Prosper soil has only slight limitations for cropping, but the wetness of the Crossplain soil is a major concern of management.

Most areas are cultivated. These soils are well suited to all crops grown in the survey area. In a wet year, these soils, especially the Crossplain soil, are better suited to late-planted crops than to spring-sown small grain. Prosper soil is in capability unit I–3, pasture group K, windbreak group 1; Crossplain soil is in capability unit IIw–1, pasture group A, windbreak group 2.

Redstoe Series

The Redstoe series consists of moderately deep, well drained, nearly level to undulating, calcareous, silty soils on uplands. These soils formed in material that was weathered from the underlying siltstone. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark gray silt loam about 8 inches thick. Below this is about 9 inches of dark grayish brown and gray silt loam. The underlying material, to a depth of 27 inches, is white silty clay loam. White siltstone is at a depth of 27 inches. All layers are calcareous.

Redstoe soils have medium fertility and moderate organic-matter content. Permeability is moderate, and the available water capacity is low.

Most areas remain in native grassland and are used for hay and pasture; a few areas are cultivated.

Representative profile of Redstoe silt loam, 0 to 6 percent slopes, in native grassland, 2,495 feet west and 495 feet north of the southeast corner of sec. 18, T. 101 N., R. 59 W.

A1—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak medium and fine granular; soft, very friable, slightly sticky and slightly plastic; slight effervescence; neutral; clear wavy boundary.

AC1ca—8 to 12 inches; dark grayish brown (10YR 4/2) and gray (10YR 5/1) silt loam, very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak medium and fine subangular blocky; soft, very friable, slightly sticky and slightly plastic; violent effervescence; mildly alkaline; clear wavy boundary.

AC2ca—12 to 17 inches; gray (10YR 6/1) silt loam, light olive brown (2.5Y 5/3) moist; coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; violent effervescence; mildly alkaline; clear wavy boundary.

Cca—17 to 27 inches; white (10YR 8/2) silty clay loam, very pale brown (10YR 7/3) moist; moderate medium and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; violent effervescence; mildly alkaline; gradual wavy boundary.

Cr1—27 to 38 inches; white (10YR 8/2) weathered siltstone, very pale brown (10YR 7/3) moist; platy bedrock structure; cemented but crushes to friable fine earth when moist; few fine light yellowish brown (2.5Y 6/6) segregations of iron; violent effervescence; mildly alkaline; diffuse irregular boundary.

Cr2—38 to 60 inches; white (10YR 8/2) bedded siltstone, very pale brown (10YR 7/3) moist; platy bedrock structure; cemented; few fine light yellowish brown (2.5Y 6/6) and dark brown (7.5Y 4/4) segregations of iron and manganese oxides; strong effervescence; mildly alkaline.

Free carbonates are at or above a depth of 6 inches. Depth to siltstone is 20 to 40 inches. Calcium carbonate equivalent ranges from 30 to 70 percent in the AC and C horizons. The A horizon is dark gray to grayish brown and in places is loam. It is neutral to moderately alkaline and is 7 to 10 inches thick. The AC horizon is dark gray to light yellowish brown in hue of 10YR or 2.5Y and is silt loam, loam, or light silty clay loam. It is mildly alkaline or moderately alkaline and is 7 to 12 inches thick. The C horizon is light brownish gray to white or pale yellow in hue of 10YR, 2.5Y, or 5Y. The Cca horizon is silt loam or silty clay loam. The siltstone in the Cr horizon is cemented, but it is rippable. In places, gypsum is in seams and cracks of the siltstone.

Redstoe soils contain more silt and are more calcareous than the nearby Clarno, Enet, and Ethan soils.

They are underlain by siltstone at a moderate depth instead of by glacial till or gravelly sand.

ReB—Redstoe silt loam, 0 to 6 percent slopes. This is a nearly level to undulating soil on uplands in Hanson County. Areas range from 5 to 60 acres in size and consist of flats and convex rises. A few entrenched drainageways cut back into the areas. This soil has the profile described as representative of the series except that in a few places the depth to siltstone is less than 20 inches.

Included with this soil in mapping are small areas of Delmont, Enet, and Henkin soils on some of the convex rises.

Runoff is medium. The high lime content affects crop growth. Cultivated areas are subject to soil blowing and erosion. Controlling erosion and soil blowing and improving fertility are the main concerns of management if this soil is used for crops.

Most areas remain in native grassland and are used for pasture; a few are cultivated. Capability unit IIIe–6, pasture group G, windbreak group 8.

Salmo Series

The Salmo series consists of deep, poorly drained, nearly level, calcareous, silty soils on bottom lands. These soils formed in alluvium. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is dark gray silty clay loam about 13 inches thick. It contains spots and streaks of salt. The next layer is dark gray silty clay loam about 6 inches thick. It is also high in salt content. Below this are layers of black and very dark gray silty clay loam that represent a buried soil. Dark gray silty clay loam is at a depth of 43 inches. All layers are calcareous.

Salmo soils have medium fertility and high organic-matter content. Permeability is moderately slow, and the available water capacity is high. These soils are subject to flooding by stream overflow, and they have a water table above a depth of 2.5 feet early in the growing season.

Most areas remain in native grassland and are used for hay or for grazing; a few are cultivated.

Representative profile of Salmo silty clay loam, in native grassland that formerly was cultivated, 1,770 feet west and 410 feet south of the northeast corner of sec. 34, T. 98 N., R. 59 W.

Apsa—0 to 8 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak thick platy structure parting to weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; many fine threads and spots of salts; strong effervescence; mildly alkaline; clear smooth boundary.

A12sa—8 to 13 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium prismatic structure parting to weak medium and fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many fine threads and spots of salts; strong effervescence; mildly alkaline; clear wavy boundary.

C1cs—13 to 19 inches; dark gray (2.5Y 4/1) silty clay loam, black (N 2/0) moist; few fine faint mottles of light olive brown (2.5Y 5/6) moist; weak coarse and medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine threads and spots of salts; common medium nests of gypsum; strong effervescence; mildly alkaline; clear irregular boundary.

A11b—19 to 27 inches; black (2.5Y 2/1) silty clay loam, black (N 2/0) moist; weak coarse and medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few threads and spots of salts; strong effervescence; neutral; diffuse boundary.

A12b—27 to 34 inches; black (2.5Y 2/1) silty clay loam, black (N 2/0) moist; weak coarse and medium subangular blocky structure; hard, firm, sticky and plastic; common fine nests of gypsum; slight effervescence; neutral; clear irregular boundary.

A13bca—34 to 43 inches; very dark gray (2.5Y 3/1) silty clay loam, black (5Y 2/1) moist; weak coarse and medium subangular blocky structure; very hard, firm, sticky and plastic; few fine nests of gypsum; few segregations of lime; slight effervescence; neutral; abrupt irregular boundary.

C2g—43 to 60 inches; dark gray (2.5Y 4/1) silty clay loam, black (N 2/0) moist; weak coarse and medium subangular blocky structure; very hard, firm, sticky and plastic; moderate efflorescence of salts when dry; common medium nests of gypsum; many coarse segregations of lime; slight effervescence; neutral.

Free carbonates are within 10 inches of the surface. The soil texture is silty clay loam or silt loam to a depth of 40 inches or more. Electrical conductivity in the upper 20 inches of the profile ranges from 4 to 10 millimhos. The A horizon is in hue of 10YR or 2.5Y. Typically it is mildly alkaline or moderately alkaline, but in places the upper part is medium acid to neutral. It is 12 to 25 inches thick. Some profiles have an AC horizon. The C horizon is dark gray to light olive gray in hue of 2.5Y or 5Y and is neutral. Below a depth of 40 inches, the C horizon commonly is stratified with lenses of loamy or sandy material, and in places the lower part of it is gravelly sand. Most profiles have a buried A horizon within the C horizon.

Salmo soils are near Bon, Chaska, Clamo, Durrstein, James, and Lamo soils. They contain more salts in the upper part of the profile than the Bon, Chaska, and Lamo soils. In addition, they are more poorly drained than the Bon and Lamo soils and are more silty than the Bon and Chaska soils. The Salmo soils contain less clay than the Clamo, Durrstein, and James soils and contain more salts than the Clamo soils.

Sa—Salmo silty clay loam. This is a nearly level soil in low areas on bottom land. Areas are irregular in

shape and range from 5 to 15 acres in size. Slopes are 0 to 2 percent and are plane to slightly concave.

Included with this soil in mapping are small areas of Chaska, Clamo, James, Lamo, and Wann soils. Chaska, Clamo, Lamo, and Wann soils commonly are on slightly higher levels of the flood plain. The James soils are intermingled with the Salmo soils in some of the low areas.

Runoff is slow. Flooding from stream overflow occurs in most years. Crop growth is affected by a high water table and by the high salt content. In some years this soil is too wet for cultivation. Wetness and the high salt content are major concerns of management where this soil is used for crops.

Most areas remain in native vegetation and are used for pasture and hay; a few areas are cultivated. This soil is poorly suited to crops. Late-planted crops are better suited than spring-sown small grain. Capability unit IVw-2, pasture group J, windbreak group 10.

Stickney Series

The Stickney series consists of deep, moderately well drained, nearly level, silty soils on uplands. These soils formed in glacial till. They have a claypan subsoil. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark gray silty clay loam about 9 inches thick. The subsurface layer is grayish brown silt loam about 6 inches thick. The subsoil, about 25 inches thick, is dark gray silty clay loam in the upper and middle parts and light brownish gray calcareous silty clay loam in the lower part. The underlying material is calcareous clay loam. It is light brownish gray to a depth of 50 inches and light gray and light yellowish brown below that.

Stickney soils have medium fertility and moderate organic-matter content. Permeability is slow, and the available water capacity is high.

Most areas are used for crops; a few remain in native grassland and are used for hay and for grazing.

Stickney soils in this survey area are mapped only with the Clarno, Dudley, and Prosper soils.

Representative profile of Stickney silty clay loam, in an area of Dudley-Stickney complex, 0 to 2 percent slopes, in cultivation, 1,120 feet west and 975 feet north of the southeast corner of sec. 36, T. 99 N., R. 57 W.

Ap—0 to 9 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, very friable, slightly sticky and slightly plastic; medium acid; abrupt smooth boundary.

A2—9 to 15 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak thick platy structure parting to weak fine and medium subangular blocky; slightly hard, very friable; slightly acid; clear wavy boundary.

B21t—15 to 18 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium columnar structure parting to strong fine and medium blocky; very hard, firm, sticky and plastic; coats of gray (10YR 5/1) on caps of columns; shiny coats on vertical faces of peds; slightly acid; clear smooth boundary.

B22t—18 to 23 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, firm, sticky and plastic; shiny coats of very dark gray (10YR 3/1) on all faces of peds; mildly alkaline; clear irregular boundary.

B23tcs—23 to 33 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; weak coarse prismatic structure parting to moderate coarse and medium subangular blocky; very hard, firm, sticky and plastic; shiny coats on all faces of peds; many fine and medium nests of gypsum crystals; mildly alkaline; clear wavy boundary.

B3cs—33 to 40 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; few fine faint mottles of dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, firm, sticky and plastic; shiny coats on vertical faces of peds; many coarse nests of gypsum crystals; few fine segregations of lime; slight effervescence; mildly alkaline; clear wavy boundary.

C1csca—40 to 50 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; many medium and coarse distinct mottles of olive yellow (2.5Y 6/6) and light olive brown (2.5Y 5/6) moist; weak coarse subangular blocky structure; hard, friable, sticky and slightly plastic; many coarse nests of gypsum crystals; common fine and medium segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2csca—50 to 60 inches; light gray (2.5Y 7/1) and light yellowish brown (2.5Y 6/4) clay loam, grayish brown (2.5Y 5/2) moist; many medium and coarse distinct mottles of olive yellow (2.5Y 6/6) and light olive brown (2.5Y 5/6) moist; massive; hard, friable, sticky and slightly plastic; many coarse nests of gypsum crystals; common coarse and medium segregations of lime; strong effervescence; moderately alkaline.

The solum is 25 to 47 inches thick. Depth to free carbonates is 20 to 47 inches. Gypsum crystals are below a depth of 20 inches, and they are above or mixed with horizons of lime accumulation. The A1 horizon is very dark gray to grayish brown and is silty clay loam, silt loam, or loam. It is medium acid

to neutral and is 7 to 9 inches thick. The A2 horizon is gray to light brownish gray and is loam, silt loam, or light silty clay loam. It is slightly acid or neutral and is 2 to 6 inches thick. Some profiles have a B&A horizon. The B2t horizon is very dark gray to grayish brown in hue of 10YR or 2.5Y. It is silty clay loam, clay loam, silty clay, or clay 11 to 20 inches thick. Some profiles lack nests of gypsum crystals in the lower part of the B2t horizon. The B3 horizon is grayish brown to light yellowish brown, and in places it is silty clay loam. The C horizon is gray to pale olive in hue of 2.5Y or 5Y. It is loam to silty clay loam and is mildly alkaline or moderately alkaline.

Stickney soils are mapped with Clarno, Dudley, and Prosper soils. They have a more clayey B horizon and contain more sodium than the Clarno and Prosper soils, and they have a thicker A horizon and generally have sodium at a greater depth than the Dudley soils.

Storla Variant

The Storla variant consists of poorly drained, nearly level, calcareous, loamy soils on uplands. These soils are moderately deep over gravelly sand. They formed in glacial melt-water deposits. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is dark gray loam about 9 inches thick. The next layer is gray loam and gravelly loam that extends to a depth of 27 inches. Olive gray and gray gravelly sand is at a depth of 27 inches. All layers are calcareous.

Storla soils have medium fertility and moderate to high organic-matter content. Permeability is moderate to a depth of 27 inches and rapid in the underlying gravelly sand. The available water capacity is low. Storla soils rarely are flooded, but they have a seasonal high water table at a depth of 1 to 4 feet.

Many areas are used for crops and tame pasture; some remain in native grassland and are used for pasture or hay.

Representative profile of Storla variant loam, in native grassland that formerly was cultivated, 460 feet north and 240 feet east of the southwest corner of sec. 21, T. 99 N., R. 58 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; abrupt smooth boundary.

A12—6 to 9 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; clear wavy boundary.

ACca—9 to 17 inches; gray (2.5Y 5/1) loam, dark gray (2.5Y 4/1) moist; few fine distinct mottles of olive yellow (2.5Y 6/6) moist; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; coats of dark gray (2.5Y 4/1) moist on faces of peds; violent effervescence; moderately alkaline; clear wavy boundary.

C1ca—17 to 23 inches; gray (2.5Y 6/1) loam, gray (2.5Y 5/1) moist; few fine faint mottles of olive yellow (2.5Y 6/6) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—23 to 27 inches; gray (2.5Y 6/1) gravelly loam, gray (2.5Y 5/1) moist; few fine distinct mottles of olive yellow (2.5Y 6/6) moist; weak medium subangular blocky structure; slightly hard, very friable; strong effervescence; moderately alkaline; clear wavy boundary.

IIC3g—27 to 33 inches; olive gray (5Y 5/2) and gray (5Y 6/1) gravelly coarse sand, olive gray (5Y 5/2) and dark gray (5Y 4/1) moist; common medium and coarse prominent mottles of olive yellow (2.5Y 6/6) and dark yellowish brown (10YR 4/4) moist; single grained; loose; few medium dark segregations of iron and manganese oxides; gravel coated with lime; strong effervescence; moderately alkaline; gradual wavy boundary.

IIC4g—33 to 48 inches; gray (5Y 6/1) gravelly sand, olive gray (5Y 5/2) moist; many medium and coarse prominent mottles of olive yellow (2.5Y 6/6) and dark yellowish brown (10YR 4/4) moist; single grained; loose; common fine to coarse dark segregations of iron and manganese oxides; gravel coated with lime; strong effervescence; moderately alkaline; gradual wavy boundary.

IIC5g—48 to 60 inches; multicolored gravelly sand; many medium and coarse prominent mottles of olive yellow (2.5Y 6/6) and dark yellowish brown (10YR 4/4) moist; single grained; loose; many medium and coarse dark segregations and few concretions of iron and manganese oxides; gravel coated with lime; strong effervescence; moderately alkaline.

Depth to free carbonates is 6 inches or less. Depth to gravelly sand is 20 to 36 inches. The calcium carbonate equivalent in the AC horizon and upper part of the C horizon is 20 to 40 percent. Reaction is neutral to moderately alkaline in the A1 horizon and is mildly alkaline or moderately alkaline in the AC and C horizons. The A horizon is very dark gray to dark grayish brown in hue of 10YR or 2.5Y. It is loam or silt loam and is 6 to 11 inches thick. The AC horizon is dark gray to light brownish gray in hue of 10YR or 2.5Y, and in places it is silt loam. It is 5 to 8 inches thick. The upper part of the C horizon is gray or light gray loam, gravelly loam, sandy loam, or gravelly sandy loam.

The Storla variant in this survey area is wetter and more poorly drained than is defined as the range for the Storla series.

The Storla variant is near the Dimo and Fedora soils. It contains more carbonates than the Dimo soils and has a more gravelly C horizon than the Fedora soils.

St—Storla variant loam. This is a nearly level soil in broad upland basins in Hutchinson County. Areas range from 5 to 100 acres in size. Slopes are 0 to 2 percent. Poorly defined, sluggish drainageways are common in these areas.

Included with this soil in mapping are small areas of Delmont, Dimo, and Henkin soils. The Dimo soils are along some of the drainageways, and the Delmont and Henkin soils are on low rises above the Storla variant.

Runoff is slow. Wetness resulting from a seasonal high water table affects the use of this soil for crops. The high lime content affects crop growth and causes the soil to blow easily where farmed. Wetness, maintaining fertility, and controlling soil blowing are the main concerns of management.

Many areas are in tame pasture, and a few are cultivated. This soil is poorly suited to crops unless adequately drained. It is suitable for ground-water dugouts (fig. 10). Capability unit IVw–2, pasture group A, windbreak group 2.

Talmo Series

The Talmo series consists of excessively drained, gently rolling to rolling, loamy soils on uplands. These soils are very shallow over gravelly sand. They formed in glacial melt-water deposits. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is dark grayish brown gravelly loam about 8 inches thick. The next layer is grayish brown gravelly sand about 22 inches thick. Light brownish gray gravelly sand is at a depth of 30 inches. All layers are calcareous.

Talmo soils have low fertility and moderately low organic-matter content. Permeability is rapid, and the available water capacity is low.

Many areas remain in native grassland and are used for grazing, and some are cultivated.

Talmo soils in this survey area are mapped only with Delmont soils.

Representative profile of Talmo gravelly loam, in an area of Delmont-Talmo complex, 6 to 12 percent slopes, in cultivation, 1,975 feet east and 122 feet north of the southwest corner of sec. 19, T. 100 N., R. 58 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark brown (10YR 2/2) moist; weak coarse subangular blocky structure parting to weak fine granular; slightly hard, friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

IIC1ca—8 to 30 inches; grayish brown (10YR 5/2) gravelly sand, dark grayish brown (10YR 4/2) and brown (10YR 4/3) moist; single grained; loose; gravel coated with lime; strong effervescence; moderately alkaline; gradual wavy boundary.

IIC2—30 to 50 inches; light brownish gray (10YR 6/2) gravelly sand, grayish brown (10YR 5/2) and dark yellowish

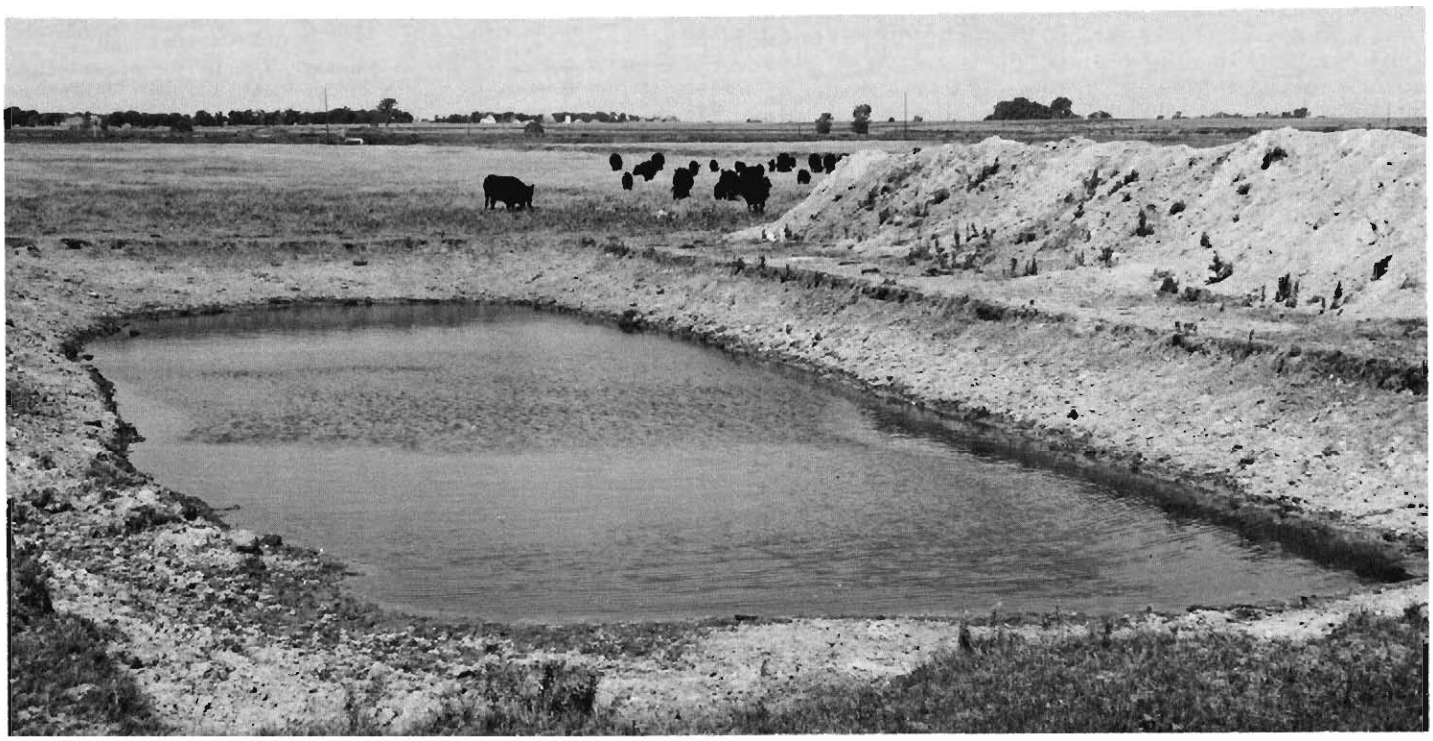

Figure 10.—Ground-water dugout in an area of Storla variant loam.

brown (10YR 4/4) moist; single grained; loose; strong effervescence; moderately alkaline; diffuse boundary.

IIC3—50 to 60 inches; light brownish gray (10YR 6/2) medium and coarse sand, grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/4) moist; single grained; loose; strong effervescence; moderately alkaline.

Depth to free carbonates is 10 inches or less. Depth to gravelly sand is 10 inches or less. The A horizon is dark gray to grayish brown and commonly is gravelly loam or gravelly sandy loam. It is neutral or mildly alkaline and is 7 to 10 inches thick. The IIC horizon is grayish brown to pale yellow in hue of 10YR or 2.5Y. In some places it is very gravelly, and in other places it is stratified with thin lenses of finer textures. The IIC horizon is mildly alkaline or moderately alkaline.

Talmo soils are near Betts and Delmont soils. They have a more gravelly C horizon than the Betts soils and are shallower to gravelly sand than the Delmont soils.

Tetonka Series

The Tetonka series consists of deep, poorly drained, level and nearly level, silty soils in closed depressions and in slightly depressed drainageways on uplands. These soils have a clayey subsoil. They formed in alluvium that washed from adjacent soils. The native vegetation consisted mainly of tall and mid grasses and water-loving sedges.

In a representative profile the surface layer is dark gray silty clay loam about 8 inches thick. The subsurface layer, about 9 inches thick, is gray silt loam. The subsoil, about 31 inches thick, is silty clay. It is dark gray in the upper part, dark gray and grayish brown in the middle part, and grayish brown in the lower part (fig. 11). The underlying material is gray and light gray calcareous clay loam and loam.

Tetonka soils have medium fertility and moderate organic-matter content. Permeability is very slow, and the available water capacity is high. These soils are flooded by the ponding of runoff from adjacent soils; the water remains until it evaporates. They have a water table within a depth of 5 feet except during dry years.

Many areas are used for crops. Some of the more poorly drained areas remain in native grassland and are used for hay and pasture.

Representative profile of Tetonka silty clay loam, in native grassland, 1,440 feet south and 508 feet east of the northwest corner of sec. 14, T. 99 N., R. 58 W.

A1—0 to 8 inches; dark gray (10YR 4/1) light silty clay loam, black (10YR 2/1) moist; few medium distinct mottles of dark yellowish brown (10YR 4/4) moist; weak fine granular structure; soft, very friable; medium acid; clear wavy boundary.

A21—8 to 11 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; few medium distinct mottles of dark yellowish brown (10YR 4/4) moist; weak thin platy structure; soft, very friable; few rounded dark concretions of iron and manganese oxides; medium acid; clear wavy boundary.

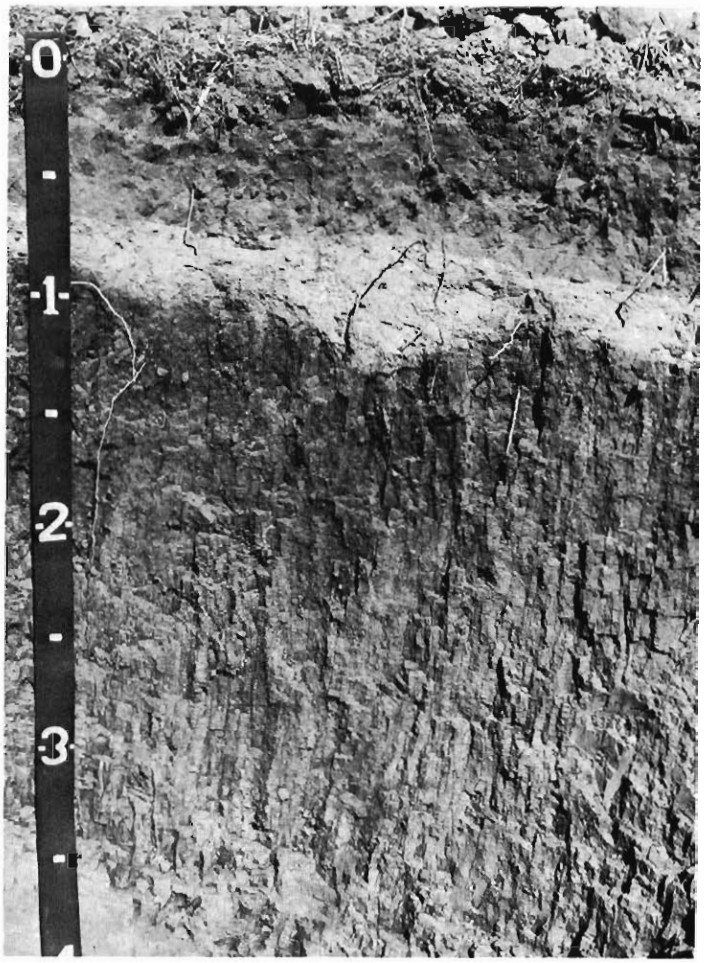

Figure 11.—This profile of Tetonka silty clay loam has a light-colored subsurface layer of gray silt loam underlain by a subsoil of silty clay.

A22—11 to 17 inches; gray (10YR 6/1) silt loam, dark gray (10YR 4/1) moist; few fine faint mottles of dark yellowish brown (10YR 4/4) moist; weak thin platy structure; soft, very friable; few rounded dark concretions of iron and manganese oxides; slightly acid; clear wavy boundary.

B&A—17 to 21 inches; dark gray (2.5Y 4/1) silty clay (B), very dark gray (2.5Y 3/1) moist and gray (10YR 6/1) silt loam (A), dark gray (10YR 4/1) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic (B); soft, very friable (A); few rounded dark concretions of iron and manganese oxides; slightly acid; clear wavy boundary.

B21t—21 to 30 inches; dark gray (2.5Y 4/1) silty clay, very dark gray (2.5Y 3/1) moist; weak coarse prismatic structure parting

to moderate medium and coarse subangular blocky; very hard, very firm, sticky and plastic; shiny coats on faces of peds; slightly acid; gradual wavy boundary.

B22t—30 to 42 inches; dark gray (2.5Y 4/1) and grayish brown (2.5Y 5/2) silty clay, very dark gray (2.5Y 3/1) and very dark grayish brown (2.5Y 3/2) moist; weak coarse subangular blocky structure; very hard, very firm, sticky and plastic; shiny coats on faces of peds; neutral; gradual wavy boundary.

B3—42 to 48 inches; grayish brown (2.5Y 5/2) silty clay, olive brown (2.5Y 4/3) moist; many medium distinct mottles of olive yellow (2.5Y 6/6) moist; weak coarse subangular blocky structure; very hard, very firm, sticky and plastic; coats of dark gray (2.5Y 4/1) on faces of peds; neutral; clear wavy boundary.

C1ca—48 to 54 inches; gray (2.5Y 6/1) and light gray (2.5Y 7/1) clay loam, grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/3) moist; many medium distinct mottles of olive yellow (2.5Y 6/6) and yellowish brown (10YR 5/6) moist; massive; hard, friable, sticky and slightly plastic; few fine segregations of lime; strong effervescence; mildly alkaline; clear wavy boundary.

C2ca—54 to 60 inches; light gray (2.5Y 7/1) loam, grayish brown (2.5Y 5/2) moist; common fine and medium distinct mottles of olive yellow (2.5Y 6/6) and yellowish brown (10YR 5/6) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine segregations of lime; strong effervescence; mildly alkaline.

The solum is 33 to 71 inches thick. Depth to free carbonates is 36 to more than 60 inches. In places, a 1- to 3-inch layer of partly decomposed organic material is on the surface. The A1 horizon is dark gray to grayish brown, and in places it is silt loam. It is medium acid or slightly acid and is 6 to 12 inches thick. The A2 horizon is dark gray to light brownish gray and in places is light silty clay loam. It is medium acid to neutral and is 4 to 10 inches thick. Some profiles lack a B&A horizon. The B2t horizon is dark gray to olive gray and has hue of 2.5Y or 5Y. It commonly is silty clay, but in places it is clay, clay loam, or silty clay loam. It is 18 to 27 inches thick. The B3 horizon is gray to light olive gray and has hue of 2.5Y or 5Y, and in places it is clay or clay loam. The B3 horizon is calcareous in some profiles. The C horizon is sandy loam to silty clay loam and in places contains nests of gypsum crystals.

Tetonka soils are near Crossplain, Harps, Whitewood, and Worthing soils. The Tetonka soils have an A2 horizon that Crossplain and Worthing soils lack. They are better drained than the Worthing soils. They contain less calcium carbonate than the Harps soils and have a more clayey B horizon than the Whitewood soils.

Te—Tetonka silty clay loam. This is a level soil in closed depressions and along drainageways on uplands. The areas in depressions are circular to oval, and the areas along drainageways are long and narrow. Areas range from 2 to 20 acres in size. Slopes are 0 to 2 percent. This Tetonka soil has the profile described as representative of the series, but in a few places the combined thickness of the surface and subsurface layers is less than 10 inches.

Included with this soil in mapping are small areas of Crossplain, Harps, and Worthing soils. The Crossplain soils are on the edge of the closed depressions, the Harps soils are on the edge of areas along drainageways, and the Worthing soils are in the lower part of some of the depressions.

Runoff is ponded, and water commonly remains on the surface until it evaporates. Fieldwork commonly is delayed because of wetness. Crops are drowned or growth is seriously retarded in some years. This soil absorbs water slowly and compacts if it is farmed when wet. Wetness is the main concern of management.

Most areas are cultivated. If adequately drained, this soil is moderately well suited to most crops grown in the survey area. In undrained areas, it is best suited to late-planted crops or to tame pasture and hay crops. Capability unit IIw–1 if drained, IVw–2 if undrained; pasture group A if drained, group B if undrained; windbreak group 10.

Tt—Tetonka-Harps complex. These are nearly level soils in upland basins. Areas consist of closed depressions and broad swales that connect the depressions. Slopes are 0 to 3 percent. The mapped areas consist of about 65 percent Tetonka soil, 25 percent Harps soil, and 10 percent other soils. The Tetonka soil is in the closed depressions and the low part of the broad swales, and the Harps soil is on very slight rises in the swales. This Tetonka soil has a surface layer of silty clay loam. It has thinner surface and subsurface layers than the soil described as representative of the series. This Harps soil has a loam surface layer, and it has the profile described as representative of the series.

Included with these soils in mapping are small areas of Crossplain and Davison soils on the edge of some areas.

Runoff is slow on the Harps soil and ponded on the Tetonka soil. Fieldwork is delayed in most years because of wetness from flooding and from a high water table. In addition, the high lime content of the Harps soil affects crop growth and causes the soil to blow easily. Wetness is the main concern of management.

Most areas are cultivated. In most areas drainage is adequate for most of the crops common to the survey area. In wet years these soils are better suited to late-seeded crops than to spring-sown small grain. Capability unit IIw–1; pasture group A; Tetonka soil is in windbreak group 10, Harps soil is in windbreak group 2.

Tw—Tetonka and Whitewood silty clay loams. These are nearly level soils in swales and along drainageways on uplands. Areas are long and narrow and range from 3 to 25 acres in size. Slopes are 0 to 2 percent and are plane to slightly concave. Some areas are mostly Tetonka soil, and others consist of both soils in proportions that vary. This Tetonka soil has a profile simi-

lar to the one described as representative of the series, but the surface layer is thicker and the subsurface layer is thinner. This Whitewood soil has the profile described as representative of the series, but in a few places the surface layer and subsoil are loam or clay loam.

Included with these soils in mapping are small areas of Clarno, Crossplain, Harps, and Prosper soils on the edge of the mapped areas.

Runoff is slow, and it is ponded on the lower part of the landscape. Fieldwork commonly is delayed by wetness resulting from flooding and from a high water table. In some years, planted crops are drowned or their growth is seriously retarded. Wetness is the main concern of management.

Most areas are cultivated. If adequately drained, these soils are moderately well suited to all crops grown in the survey area. They are better suited to late-planted crops than to spring-sown small grain in wet years. Capability unit IIw–1; pasture group A; Tetonka soil is in windbreak group 10, Whitewood soil is in windbreak group 2.

Wann Series

The Wann series consists of deep, somewhat poorly drained, nearly level, loamy soils on bottom land. These soils formed in stratified alluvium. The native vegetation consisted mainly of tall grasses; deciduous trees and shrubs were in some areas.

In a representative profile the surface layer is dark gray calcareous loam about 11 inches thick. The next layer, about 5 inches thick, is dark grayish brown calcareous loam. The underlying material, to a depth of 48 inches, is grayish brown calcareous fine sandy loam. Below this is dark grayish brown calcareous loam.

Wann soils have medium fertility and moderate organic-matter content. Permeability is moderately rapid, and the available water capacity is high. Wann soils are subject to flooding for brief periods and they have a seasonal high water table at a depth of 2.2 to 6 feet.

Many areas are cultivated; some remain in native vegetation and are used for hay and for grazing.

Representative profile of Wann loam, in cultivation, 2,115 feet west and 1,760 feet north of the southeast corner of sec. 18, T. 98 N., R. 57 W.

Ap—0 to 11 inches; dark gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; few fine and medium distinct mottles of dark yellowish brown (10YR 4/4) and olive yellow (2.5Y 6/6) moist; weak coarse subangular blocky structure parting to weak medium and fine granular; slightly hard, friable; slight effervescence; neutral; abrupt smooth boundary.

AC—11 to 16 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; many fine and medium distinct mottles of olive yellow (2.5Y 6/6) and dark yellowish brown (10YR 4/4) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable; few fine streaks of segregated lime; strong effervescence; mildly alkaline; clear wavy boundary.

C1—16 to 38 inches; grayish brown (10YR 5/2) fine sandy loam stratified with thin lenses of silt loam, very dark grayish brown (10YR 3/2) moist; many fine and medium distinct mottles of dark yellowish brown (10YR 4/4), very dark brown (10YR 2/2), and olive yellow (2.5Y 6/6) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; strong effervescence; mildly alkaline; clear wavy boundary.

C2—38 to 48 inches; grayish brown (10YR 5/2) fine sandy loam stratified with thin lenses of silt loam and loamy sand, very dark grayish brown (10YR 3/2) moist; many fine and medium distinct mottles of dark yellowish brown (10YR 4/4), very dark brown (10YR 2/2), and olive yellow (2.5Y 6/6) moist; massive; slightly hard, very friable; strong effervescence; mildly alkaline; clear wavy boundary.

Ab—48 to 60 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; many fine and medium distinct mottles of dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable; few fine streaks of segregated lime; strong effervescence; mildly alkaline.

Depth to free carbonates is 15 inches or less. The A horizon is dark gray or dark grayish brown and ranges from fine sandy loam to silt loam. It is slightly acid or neutral and is 11 to 16 inches thick. Some profiles lack an AC horizon. The C horizon is gray to light yellowish brown in hue of 10YR or 2.5Y. It commonly is fine sandy loam or sandy loam but is stratified with finer or coarser material in the lower part. It is mildly alkaline or moderately alkaline.

When moist, Wann soils in this survey area have darker colors in the C horizon than is defined as the range for the series, but this difference does not significantly alter their use or behavior.

Wann soils contain more sand than the nearby Chaska, Clamo, and Lamo soils.

Wa—Wann loam. This is a nearly level soil on low mounds and sandbar remnants on bottom land near the James River channel in Hutchinson County. Areas are narrow and range from 3 to 40 acres in size. Slopes are 0 to 2 percent and are plane to slightly convex. This soil has the profile described as representative of the series, but in places the underlying material is more sandy.

Included with this soil in mapping are small areas of Clamo and Lamo soils on the lower part of the landscape.

Runoff is slow. This soil is subject to flooding for brief periods. Fieldwork is delayed in some years by wetness resulting from flooding and from a seasonal high water table. This soil is subject to soil blowing if used for crops. Wetness and controlling soil blowing are the main concerns of management.

Most areas are cultivated. This soil is moderately well suited to most crops grown in the survey area. In

some years it is better suited to late-seeded row crops than to spring-sown small grain. Capability unit IIIw–4, pasture group A, windbreak group 2.

Wentworth Series

The Wentworth series consists of deep, well drained, gently sloping, silty soils on uplands. These soils formed in glacial drift. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark grayish brown silt loam about 10 inches thick. The subsoil, about 16 inches thick, is silty clay loam. It is dark grayish brown and brown in the upper and middle parts and light brownish gray in the lower part. The lower part is calcareous. The underlying material, to a depth of 49 inches, is light gray and gray, calcareous silty clay loam and light gray calcareous silt loam. Light gray calcareous sandy loam is at a depth of 49 inches.

Wentworth soils have medium to high fertility and moderate to high organic-matter content. Permeability is moderate, and the available water capacity is high.

Most areas are used for crops; a few remain in native grassland and are used for hay and for grazing.

Wentworth soils in this survey area are mapped only with Egan soils.

Representative profile of Wentworth silt loam, in an area of Egan and Wentworth silt loams, 2 to 6 percent slopes, in cultivation, 2,010 feet south and 335 feet east of the northwest corner of sec. 1, T. 97 N., R. 56 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak coarse and medium subangular blocky structure parting to weak fine granular; slightly hard, friable; medium acid; abrupt smooth boundary.

B21—10 to 16 inches; dark grayish brown (10YR 4/2) and brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; shiny coats on faces of peds; slightly acid; clear wavy boundary.

B22—16 to 21 inches; brown (10YR 5/3) and dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) and dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; shiny coats on faces of peds; neutral; clear wavy boundary.

B3ca—21 to 26 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; hard, friable, slightly sticky; common medium spots and streaks of segregated lime; strong effervescence; mildly alkaline; clear wavy boundary.

C1ca—26 to 30 inches; light gray (2.5Y 7/1) and gray (2.5Y 6/1) silty clay loam, gray (2.5Y 5/1) moist; common medium and coarse distinct mottles of dark yellowish brown (10YR 4/4) and light olive brown (2.5Y 5/6) moist; weak coarse subangular blocky structure; hard, friable, slightly sticky; common medium segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C2ca—30 to 49 inches; light gray (2.5Y 7/1) silt loam, gray (2.5Y 5/1) moist; common medium and coarse distinct mottles of dark yellowish brown (10YR 4/4) and light olive brown (2.5Y 5/6) moist; massive; slightly hard, very friable; few fine and medium spots and streaks of segregated lime; strong effervescence; moderately alkaline; gradual wavy boundary.

IIC3ca—49 to 60 inches; light gray (2.5Y 7/1) sandy loam, gray (2.5Y 5/1) moist; few medium and fine distinct mottles of light olive brown (2.5Y 5/6) and dark yellowish brown (10YR 4/4) moist; massive; soft, very friable; few fine segregations of lime; strong effervescence; mildly alkaline.

The solum is 20 to 38 inches thick. The silty material in which the soil formed is 40 inches or more thick. The A horizon is very dark gray to dark grayish brown and is silty clay loam in places. It is medium acid to neutral and is 5 to 10 inches thick. The B2 horizon is dark grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is silt loam in places and is 10 to 18 inches thick. The C horizon is gray to pale yellow in hue of 10YR or 2.5Y. It commonly is stratified with thin lenses of loamy or sandy material, and the lower part ranges from loamy sand to clay loam.

Wentworth soils are silty to a greater depth than the nearby Egan soils.

Whitewood Series

The Whitewood series consists of deep, somewhat poorly drained, nearly level, silty soils on uplands in swales and slightly depressed drainageways. These soils formed in alluvium that washed from adjacent soils. The native vegetation consisted mainly of tall and mid grasses.

In a representative profile the surface layer is very dark gray silty clay loam and silt loam about 15 inches thick. The subsoil is about 24 inches thick. It is dark gray silty clay loam in the upper part, dark grayish brown loam in the middle part, and grayish brown loam in the lower part. The underlying material, to a depth of 49 inches, is light brownish gray calcareous silt loam. Light brownish gray calcareous clay loam is at a depth of 49 inches.

Whitewood soils have high fertility and organic-matter content. Permeability is moderately slow, and the available water capacity is high. Whitewood soils receive runoff from adjacent soils and are subject to

flooding for very brief periods. They also have a seasonal water table within a depth of 5 feet.

Most areas are used for crops; a few remain in native grassland and are used for hay and pasture.

Whitewood soils in this survey area are mapped only with Tetonka soils.

Representative profile of Whitewood silty clay loam, in an area of Tetonka and Whitewood silty clay loams, in cultivation, 1,660 feet east and 160 feet south of the northwest corner of sec. 26, T. 102 N., R. 57 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; few fine faint mottles of light yellowish brown (10YR 6/4) moist; weak coarse and medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky; slightly acid; abrupt smooth boundary.

A12—10 to 15 inches; very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; few fine faint mottles of light yellowish brown (10YR 6/4) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, very friable, slightly sticky; slightly acid; clear wavy boundary.

B21—15 to 26 inches; dark gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) moist; common fine faint mottles of light yellowish brown (10YR 6/4) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; shiny coats on faces of peds; slightly acid; clear wavy boundary.

B22g—26 to 32 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; many medium distinct mottles of light olive brown (2.5Y 5/6) and brown (10YR 4/4) moist; weak medium and coarse prismatic structure parting to weak medium and coarse subangular blocky; hard, friable, slightly sticky and slightly plastic; shiny coats on faces of peds; neutral; clear wavy boundary.

B3g—32 to 39 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; many fine and medium distinct mottles of light olive brown (2.5Y 5/6) and yellowish brown (10YR 6/4) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; hard, friable, slightly sticky; few fine and medium dark segregations of iron and manganese oxides; mildly alkaline; abrupt wavy boundary.

C1g—39 to 49 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; many medium distinct mottles of light olive brown (2.5Y 5/6) and yellowish brown (10YR 6/4) moist; massive; hard, very friable; many fine and medium dark segregations of iron and manganese oxides; strong effervescence; mildly alkaline; clear wavy boundary.

C2g—49 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; many medium distinct mottles of light olive brown (2.5Y 5/6) and light yellowish brown (10YR 6/4) moist; massive; hard, friable, slightly sticky and slightly plastic; many fine and medium dark segregations of iron and manganese oxides; strong effervescence; mildly alkaline.

The thickness of the solum and depth to free carbonates are 28 to 52 inches. The A horizon is very dark gray or dark gray. It is slightly acid or neutral and is 14 to 20 inches thick. The B2 horizon is dark gray to grayish brown in hue of 10YR or 2.5Y. It is silty clay loam or silt loam in the upper part and clay loam or loam in the lower part. It is slightly acid to mildly alkaline and is 14 to 20 inches thick. Some profiles lack a B3 horizon, and in places the B3 horizon is calcareous. The B3 and C horizons are gray to light olive gray or light gray in hue of 2.5Y or 5Y. They range from loam to silty clay loam, but in places they are stratified with thin lenses of loamy sand or sandy loam. The B3 and C horizons are mildly alkaline or moderately alkaline.

Whitewood soils in this survey area contain more sand in the lower part of the B horizon and are dark colored to a greater depth than is defined as the range for the series, but these differences do not significantly alter their use and behavior.

Whitewood soils are near Crossplain, Onita, Prosper, Tetonka, and Worthing soils. They have a less clayey B horizon than the Crossplain, Onita, Tetonka, and Worthing soils, and they are more poorly drained and are more silty than the Prosper soils.

Worthing Series

The Worthing series consists of deep, poorly drained and very poorly drained, level soils in closed depressions on uplands. These soils formed in alluvium that washed from adjacent soils. They have a clayey subsoil. The native vegetation consisted mainly of tall grasses, sedges, and rushes.

In a representative profile the surface layer is dark gray silty clay loam about 16 inches thick. The subsoil, about 40 inches thick, is gray silty clay. The underlying material is light gray calcareous clay.

Worthing soils have high fertility and organic-matter content. Permeability is slow, and the available water capacity is high. Runoff from adjacent soils ponds on these soils, and water remains on the surface until it evaporates late in summer. The water table generally is within 5 feet of the surface.

Many areas remain in native vegetation and are used for hay crops and pasture. Some areas, generally those in which drainage has been provided, are used for crops.

Representative profile of Worthing silty clay loam, in native grassland, 1,625 feet north and 65 feet west of the southeast corner of sec. 29, T. 99 N., R. 56 W.

A11—0 to 9 inches; dark gray (2.5Y 4/1) silty

clay loam, black (2.5Y 2/1) moist; few fine faint mottles of dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure parting to moderate fine granular; hard, friable, slightly sticky and slightly plastic; few fine rounded dark concretions of iron and manganese oxides; slightly acid; clear wavy boundary.

A12—9 to 16 inches; dark gray (2.5Y 4/1) silty clay loam, black (2.5Y 2/1) moist; few fine faint mottles of dark yellowish brown (10YR 4/4) and olive brown (2.5Y 4/4); weak medium prismatic structure parting to weak medium and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; few fine and medium rounded dark concretions of iron and manganese oxides; slightly acid; clear wavy boundary.

B21t—16 to 31 inches; gray (2.5Y 5/1) silty clay, black (5Y 2/1) moist; few fine distinct mottles of very dark grayish brown (2.5Y 3/2) moist; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; very hard, very firm, sticky and plastic; shiny coats on faces of peds; few fine and medium rounded dark concretions of iron and manganese oxides; neutral; gradual wavy boundary.

B22tg—31 to 40 inches; gray (5Y 5/1) silty clay, very dark gray (5Y 3/1) moist; common medium distinct mottles of dark yellowish brown (10YR 4/4) and very dark grayish brown (2.5Y 3/2) moist; weak coarse prismatic structure parting to weak and moderate coarse and medium subangular blocky; very hard, very firm, sticky and plastic; shiny coats on faces of peds; few fine and medium rounded dark concretions of iron and manganese oxides; neutral; gradual wavy boundary.

B23tg—40 to 46 inches; gray (5Y 5/1) silty clay, very dark gray (5Y 3/1) moist; many medium and coarse distinct mottles of light olive brown (2.5Y 5/6) and dark yellowish brown (10YR 4/4) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; very hard, very firm; sticky and plastic; few fine rounded dark concretions of iron and manganese oxides; neutral; gradual wavy boundary.

B3g—46 to 56 inches; gray (5Y 6/1) silty clay, dark gray (5Y 4/1) moist; many medium and coarse distinct mottles of light olive brown (2.5Y 5/6) and dark yellowish brown (10YR 4/4) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; hard, firm, sticky and plastic; few fine rounded dark concretions and segregations of iron and manganese oxides; neutral; abrupt wavy boundary.

Cg—56 to 60 inches; light gray (5Y 7/1) silty clay, olive gray (5Y 5/2) moist; many medium and coarse prominent mottles of light olive brown (2.5Y 5/6) and dark yellowish brown (10YR 4/4) moist; massive; hard, firm, sticky and plastic; few dark segregations of iron and manganese oxides; strong effervescence; mildly alkaline.

The solum is 40 to 65 inches thick. Depth to free carbonates is 35 to 65 inches. In places, a 1- to 4-inch layer of organic material is on the surface. The A horizon is very dark gray or dark gray and has hue of 10YR or 2.5Y. It is medium acid to neutral and is 10 to 20 inches thick. The B2t horizon is very dark gray to gray and in places is silty clay loam or clay. It is slightly acid or neutral and is 25 to 35 inches thick. The B3g horizon has hue of 2.5Y or 5Y and in places is calcareous. In places, the C horizon is noncalcareous.

Worthing soils are more poorly drained than the Crossplain and Tetonka soils, and they do not have an A2 horizon, which Tetonka soils have.

Ww—Worthing silty clay loam. This is a level soil in closed depressions on uplands. Most of the areas are circular to oval in shape, and they range from 3 to 50 acres in size. Slopes are 0 to 1 percent.

Included with this soil in mapping are small areas of Crossplain, Harps, and Tetonka soils on the edge of some of the areas.

Runoff is ponded, and water remains on the surface until it evaporates. This soil compacts and loses its tilth if farmed when wet. Wetness is the main concern of management.

Most areas remain in native grassland and are used for hay and pasture. Some areas have been seeded to tame grasses, and a few areas are cultivated. This soil is suited to late-planted crops if adequately drained. In undrained areas, it is best suited to hay and pasture. Capability unit IIIw–1 if drained, Vw–2 if undrained; pasture group A if drained, group B if undrained; windbreak group 10.

Use and Management of the Soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning the use and management of soils for crops and pasture, woodland, and rangeland, as sites for buildings, highways and other transportation systems, sanitary facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Management of Cropland [2]

The survey area is dominantly cropland, and about 75 percent of the area is cultivated. Corn, oats, alfalfa, sorghum, soybeans, and tame grasses are the main crops.

Some soils can be used for a single crop for many years without damage to their physical condition. Other soils deteriorate rapidly when used continuously for one crop, especially a crop that produces little residue. Successful long-term cultivation depends on managing the soil according to its capabilities and limitations for cropland use. Controlling erosion and soil blowing, conserving moisture, and maintaining fertility and tilth are important management objectives in the survey area. A conservation cropping system tailored to the properties of each soil or group of soils is needed to meet these objectives.

Some of the practices that help control erosion and soil blowing are use of crop residue, contour farming, terracing, minimum tillage, wind stripcropping, and the use of field windbreaks. These practices also help to conserve moisture and maintain fertility and tilth. Grassed waterways and diversions and emergency tillage also help to control erosion and soil blowing. Generally, a combination of practices is most effective.

Practices that help to maintain tilth are use of crop residue, minimum tillage, timely tillage, chiseling or subsoiling, using green manure crops, and including grasses and legumes in the cropping system. These practices and practices that help control erosion and soil blowing, in addition to using chemical fertilizer and manure, help to maintain or improve fertility.

In most years, several soils are too wet for fieldwork in spring. Conserving moisture and reducing runoff on adjacent sloping soils help to reduce soil wetness. For wet soils and for soils that are high in content of salt, crops should be selected that will increase organic residue and thus eventually improve the soil. Improved drainage also helps to offset such unfavorable soil features as wetness and salinity.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects, and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained;

[2] By PAUL M. BODEN, conservation agronomist, Soil Conservation Service.

w shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage) ; *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The CAPABILITY UNIT is identified in the description of each soil mapping unit in the section "Description of the Soils." Capability units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–4 or IIIe–6.

Management by capability units

In the following pages the capability units in the survey area are described, and suggestions for the use and management of the soils are given. The capability units within a subclass are not numbered consecutively because not all of the units in the statewide system are in this survey area. The unit in which a soil has been placed is given in the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I–1

Bon loam is the only soil in this unit. It is a deep, moderately well drained, nearly level soil on bottom lands. It formed in stratified alluvium.

This soil has high fertility and organic-matter content. The available water capacity is moderate or high. Permeability is moderate. Runoff is slow. In some years this soil is subject to flooding caused by stream overflow and by runoff from adjacent soils. The additional moisture is beneficial. In most years, the limitations to cropping are slight. Maintaining fertility is the main concern of management.

This soil is well suited to the crops grown in the survey area. It is used mainly for corn, oats, sorghum, alfalfa, and tame grasses.

The use of crop residue and including grasses and legumes in the cropping system help to maintain fertility and the organic-matter content. Applying chemical fertilizer and manure is also helpful.

CAPABILITY UNIT I–2

This unit consists of deep, well drained and moderately well drained, nearly level, loamy and silty soils on uplands. Most of these soils formed in glacial till and glacial melt-water deposits, but some formed in alluvium that washed from adjacent soils.

These soils have medium to high fertility and moderate to high organic-matter content. The available water capacity is high. Permeability is moderate or moderately slow. Runoff is slow to medium, and the hazard of erosion is slight. Limitations to use of the soils for crops are slight. Maintaining fertility and tilth is the main concern of management.

These soils are well suited to all crops grown in the survey area. Corn, oats, sorghum, and soybeans are the main crops. Alfalfa and tame grasses also are grown.

Using crop residue and including grasses and legumes in the cropping system help to maintain fertility, tilth, and organic-matter content. Applying chemical fertilizer and manure also helps to maintain fertility.

CAPABILITY UNIT I–3

This unit consists of deep, moderately well drained and well drained, nearly level soils on flats and in swales on uplands. These soils have a surface layer of loam or silt loam.

Most of these soils have high fertility and organic-matter content. The available water capacity is high. Permeability is moderate or moderately slow. Runoff is slow; most of these soils receive runoff from adjacent soils. This additional moisture is beneficial in most years. The limitations to use of the soils for crops are slight. Maintaining fertility and tilth is the main concern of management.

These soils are well suited to all crops grown in the survey area. Corn, oats, soybeans, and sorghum are the main crops. Alfalfa and tame grasses also are grown.

The use of crop residue, including grasses and legumes in the cropping system, and the application of chemical fertilizer and manure help to maintain fertility and tilth.

CAPABILITY UNIT IIe–1

This unit consists of deep, moderately well drained, gently sloping soils in upland swales and on foot slopes and fans on the edge of stream valleys. These soils have a surface layer of loam or silt loam.

These soils have high fertility and organic-matter content. The available water capacity is high. Permeability is moderate or moderately slow. Runoff is medium, and most areas receive runoff from adjacent areas. Controlling erosion is the main concern of management. Maintaining fertility and tilth is also an important concern.

These soils are well suited to all crops grown in the survey area. Corn, oats, soybeans, sorghum, and alfalfa are the main crops.

The use of crop residue, contour farming, terracing, minimum tillage, and grassed waterways help to control erosion and to maintain fertility and tilth. Applying chemical fertilizer and manure also helps to maintain fertility and organic-matter content.

CAPABILITY UNIT IIe–2

This unit consists of deep, well drained, undulating soils on uplands. These soils have a loam surface layer.

These soils have medium fertility and moderate organic-matter content. The available water capacity is high. Permeability in the subsoil is moderate. Runoff is medium, and the hazard of erosion is moderate. Controlling erosion is the main concern of management.

Maintaining fertility, organic-matter content, and tilth is also an important concern.

These soils are well suited to all crops grown in the survey area. Corn, oats, sorghum, and alfalfa are the main crops.

The use of crop residue, minimum tillage, contour farming, terracing, and grassed waterways help to control erosion and to maintain fertility and tilth. If slopes are too short and irregular for contouring, the alternative is the use of more close-sown crops in the cropping system. Using grasses and legumes in the cropping system and applying chemical fertilizer and manure also help to maintain fertility and the organic-matter content.

CAPABILITY UNIT IIe-3

This unit consists of deep, well drained and moderately well drained, gently sloping soils on uplands. Most of these soils formed in silty glacial drift and have long smooth slopes. They have a surface layer of silt loam or silty clay loam.

These soils have medium to high fertility and moderate to high organic-matter content. The available water capacity is high. Permeability is moderate or moderately slow. Runoff is medium, and the hazard of erosion is moderate. Controlling erosion is the main concern of management. Maintaining fertility, organic-matter content, and tilth is also an important concern.

These soils are well suited to all crops grown in the survey area. Corn, oats, sorghum, soybeans, and alfalfa are the main crops.

The use of crop residue, contour farming, terracing, grassed waterways, and minimum tillage help to control erosion and to maintain tilth (fig. 12). Using grasses and legumes in the cropping system and applying chemical fertilizer and manure also help to maintain fertility and organic-matter content.

CAPABILITY UNIT IIe-4

This unit consists of deep, moderately well drained, nearly level to gently undulating soils on uplands. These soils have a high lime content within 15 inches of the surface. They commonly have a surface layer of loam, but in some areas it is silt loam or very fine sandy loam.

These soils have medium fertility and moderate organic-matter content. The available water capacity is moderate or high. Permeability is moderate. Runoff is slow, and the hazard of erosion is slight. The high lime content causes these soils to blow easily. It also affects crop growth by lowering the level of available phosphorus. Fieldwork is delayed in wet years because of the seasonal high water table. In most years, however, drainage is adequate for crops. Controlling soil blowing is the main concern of management. Maintaining or improving fertility and maintaining organic-matter content and tilth are also important concerns.

These soils are moderately well suited to all crops grown in the survey area. Corn, oats, sorghum, soybeans, and alfalfa are the main crops. Using crop residue, leaving the surface rough after plowing in the fall, using close-sown crops in the cropping system,

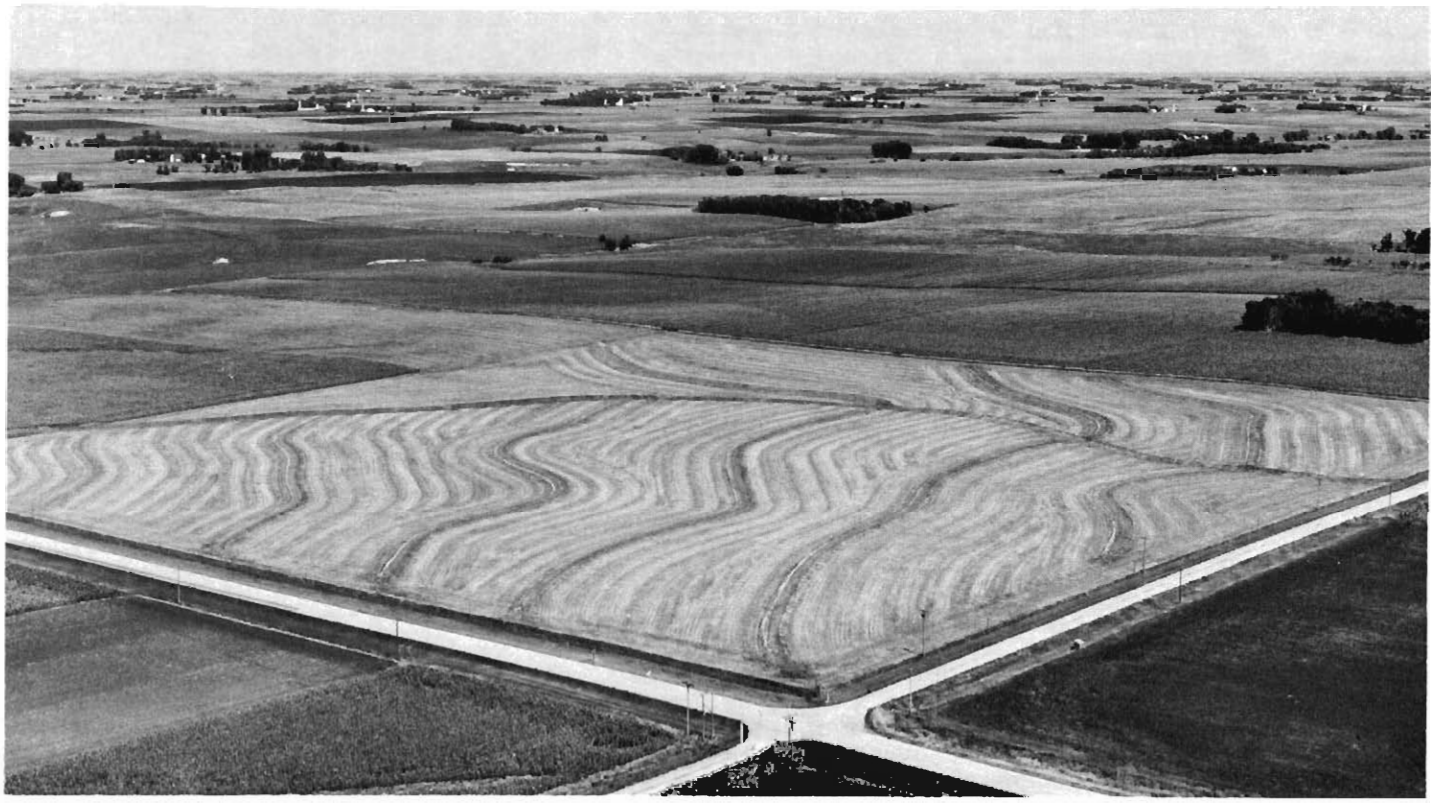

Figure 12.—Terraces in Hutchinson County in an area of Egan and Wentworth silt loams, 2 to 6 percent slopes.

and field windbreaks help to control soil blowing. Using grasses and legumes in the cropping system and applying chemical fertilizer and manure help to improve fertility and to maintain the organic-matter content and tilth.

CAPABILITY UNIT IIw-1

This unit consists of deep, poorly drained and somewhat poorly drained, nearly level and level soils on uplands in closed depressions and swales and along drainageways. These soils have a surface layer of loam, clay loam, silt loam, or silty clay loam.

These soils have medium to high fertility and moderate to high organic-matter content. The available water capacity is moderate to high. Permeability is moderately slow to very slow in most of these soils. Runoff is slow to ponded. Fieldwork is commonly delayed because of wetness from flooding and from a seasonal high water table. In most years, however, drainage is adequate for crop use. These soils compact and lose their tilth if worked when wet. Wetness is the main concern of management. Maintaining fertility and tilth is also an important concern.

These soils are moderately well suited to most crops grown in the survey area. Corn, oats, sorghum, soybeans, and alfalfa are the main crops.

Practices that reduce runoff from adjacent soils help to control wetness. Installing and maintaining surface drains help to remove excess water. Using grasses and legumes in the cropping system and applying chemical fertilizer and manure help to maintain fertility and tilth. Timely tillage also helps to maintain tilth.

CAPABILITY UNIT IIw-3

This unit consists of deep, somewhat poorly drained and poorly drained, nearly level soils on bottom lands. These soils formed in alluvium. Their surface layer is commonly silty clay loam or silt loam, but in places it is loam or very fine sandy loam.

These soils have high fertility and organic-matter content. The available water capacity is moderate or high. Permeability is moderately slow or slow in most of these soils; in some, it is moderate to moderately rapid. Runoff is slow, and these soils are subject to flooding. Fieldwork is commonly delayed in spring because of wetness resulting from flooding or from a seasonal high water table; however, in most years drainage is adequate for crops. Some of these soils compact and lose their tilth if worked when wet. Wetness is the main concern of management. Maintaining fertility and tilth is also an important concern.

These soils are well suited to most crops grown in the survey area. They are used mainly for corn, sorghum, and alfalfa. Oats and tame grasses also are grown. The soils generally are better suited to late-seeded crops than to spring-sown small grain.

Installing and maintaining surface drains helps to control wetness. Returning crop residue to the soil, including grasses and legumes in the cropping system, timely tillage, and applying chemical fertilizer and manure help to maintain fertility and tilth.

CAPABILITY UNIT IIs-1

This unit consists of deep, moderately well drained, nearly level soils on uplands. These soils have a silty clay loam surface layer, a silt loam subsurface layer, and a claypan subsoil.

These soils have medium fertility and moderate organic-matter content. The available water capacity is high. The claypan subsoil absorbs water slowly and releases it slowly to plants. These soils compact and lose their tilth if farmed when wet. Runoff is slow, and the hazards of erosion and soil blowing are slight. Improving water intake and maintaining tilth are the main concerns of management. Maintaining fertility and organic-matter content is also an important concern.

These soils are moderately well suited to all crops grown in the survey area. They are used mainly for corn, oats, sorghum, and alfalfa. They are better suited to early-maturing crops, such as small grain, and drought-resistant crops, such as sorghum, than to corn.

Returning crop residue to the soil, including grasses and legumes in the cropping system, and timely tillage help to improve water intake and to maintain tilth. Applying chemical fertilizer and manure helps to maintain fertility and organic-matter content.

CAPABILITY UNIT IIs-3

This unit consists of well drained and somewhat poorly drained, nearly level soils on uplands and terraces. These soils are moderately deep over gravelly sand and have a loam surface layer.

These soils have medium fertility and moderate to high organic-matter content. The available water capacity is moderate or low. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. Runoff is slow. Some of these soils are subject to flooding for very brief periods and have a seasonal high water table, and all of these soils are somewhat droughty in dry years because of the underlying gravelly sand. Conserving moisture is the main concern of management. Maintaining fertility and the organic-matter content and controlling soil blowing are also important concerns.

These soils are moderately well suited to all crops grown in the survey area. They are used mainly for corn, oats, sorghum, soybeans, and alfalfa.

Returning crop residue to the soil and minimum tillage help to conserve moisture and to control soil blowing. Wind stripcropping, field windbreaks, and leaving the surface rough after plowing in the fall also help to control soil blowing and to conserve moisture. Including grasses and legumes in the cropping system and applying chemical fertilizer and manure help to maintain fertility and the organic-matter content.

CAPABILITY UNIT IIIe-1

This unit consists of deep, well drained, gently rolling soils on uplands. These soils have a loam surface layer. Slopes generally are short and convex.

These soils have medium fertility and moderate organic-matter content. The available water capacity is high. Permeability in the subsoil is moderate. Runoff is medium, and the hazard of erosion is severe. Controlling erosion is the main concern of management. Conserving moisture and maintaining fertility, organic-matter content, and tilth are also important concerns.

These soils are well suited to most crops grown in

the survey area if erosion is controlled. They are used mainly for corn, sorghum, alfalfa, and tame grasses.

Returning crop residue to the soil, contour farming, terracing, grassed waterways, and minimum tillage help to control erosion. If slopes are too short and irregular for contouring and terracing, the alternative is the use of more close-sown crops and grasses and legumes in the cropping system. Applying chemical fertilizer and manure helps to maintain fertility, organic-matter content, and tilth.

CAPABILITY UNIT IIIe–2

This unit consists of deep, well drained and moderately well drained, moderately sloping soils on uplands. These soils have a surface layer of loam, silt loam, or silty clay loam. Slopes generally are moderately long and uniform.

These soils have medium to high fertility and moderate to high organic-matter content. The available water capacity is high. Permeability is moderate in the subsoil. Runoff is medium, and the hazard of erosion is severe. Controlling erosion is the main concern of management. Conserving moisture and maintaining fertility, organic-matter content, and tilth are also important concerns.

These soils are well suited to most crops grown in the survey area if erosion is controlled. They are used mainly for corn, oats, sorghum, alfalfa, and tame grasses.

Returning crop residue to the soil, contour farming, terracing, grassed waterways, and minimum tillage help to control erosion and to conserve moisture. Using grasses and legumes in the cropping system and applying chemical fertilizer and manure help to maintain fertility, organic-matter content, and tilth.

CAPABILITY UNIT IIIe–6

This unit consists of deep and moderately deep, well drained, nearly level to undulating soils on uplands. These soils have a loam or silt loam surface layer and are calcareous at or near the surface. The moderately deep soils are underlain by siltstone.

These soils have medium to low fertility and moderate to low organic-matter content. The available water capacity is high in most of the soils, but it is low in the moderately deep soils. Permeability is moderate. Runoff is medium, and the hazard of erosion is severe. These soils blow easily, and the high content of lime affects crop growth. Controlling erosion and soil blowing and improving fertility are the main concerns of management. Conserving moisture and improving the organic-matter content are also important concerns.

These soils are moderately well suited to poorly suited to crops. They are used mainly for corn, oats, sorghum, and tame grasses. They are better suited to tame grasses than to alfalfa.

Returning crop residue to the soil, including close-sown crops and tame grasses in the cropping system, and minimum tillage help to control soil blowing and erosion and to conserve moisture. Slopes generally are too short and irregular for contour farming and terracing. Using green manure crops and applying chemical fertilizer and manure help to improve fertility and the organic-matter content.

CAPABILITY UNIT IIIe–7

Henkin fine sandy loam, 2 to 6 percent slopes, is the only soil in this unit. This is a deep, well drained, and undulating soil on uplands.

This soil has medium fertility and moderate organic-matter content. The available water capacity is moderate or high, and the soil is somewhat droughty. Permeability is moderately rapid. Runoff is medium, and the soil is subject to erosion and soil blowing. Controlling erosion and soil blowing and conserving moisture are the main concerns of management. Maintaining fertility and organic-matter content is also an important concern.

This soil is moderately well suited to most crops grown in the survey area. It is used mainly for corn, oats, sorghum, soybeans, alfalfa, and tame grasses. In dry years, it is better suited to small grain and sorghum than to corn and soybeans.

Returning crop residue to the soil, contour farming, wind stripcropping, minimum tillage, use of close-sown crops, and use of field windbreaks help to control soil blowing and erosion and to conserve moisture. Using grasses and legumes in the cropping system and applying chemical fertilizer and manure help to maintain fertility and the organic-matter content.

CAPABILITY UNIT IIIe–8

This unit consists of deep, moderately well drained, undulating soils on uplands. These soils have a loam surface layer and are calcareous at or near the surface. Slopes generally are short and irregular.

These soils have medium fertility and moderate organic-matter content. The available water capacity is moderate or high. Permeability is moderate. Runoff is medium, and the hazards of erosion and soil blowing are severe. The high content of lime affects crop growth and causes the soil to blow easily. Fieldwork is delayed in some years because of wetness resulting from a seasonal high water table; however, in most years drainage is adequate for crops. Controlling erosion and soil blowing is the main concern of management. Maintaining or improving fertility and maintaining tilth and the organic-matter content are also important concerns.

These soils are moderately well suited to all crops grown in the survey area. They are used mainly for corn, oats, sorghum, soybeans, alfalfa, and tame grasses.

Returning crop residue to the soil, use of close-sown crops in the cropping system, leaving the surface rough after plowing in the fall, minimum tillage, and use of field windbreaks help to control erosion and soil blowing. Contour farming and terracing also help to control erosion, but in most areas slopes are too short and irregular for these practices. Applying chemical fertilizer and manure helps to improve fertility and organic-matter content.

CAPABILITY UNIT IIIw–1

Worthing silty clay loam is the only soil in this unit. It is a deep, poorly drained, and level soil in closed depressions on uplands.

This soil has high fertility and organic-matter content. The available water capacity is high. Permeability is slow. Runoff is ponded. Fieldwork is commonly de-

layed because of wetness resulting from ponded water and a perched water table. Where the soil has been drained, however, crops can be grown in most years. This soil compacts and loses its tilth if farmed when wet. Wetness is the main concern of management. Maintaining tilth is also an important concern.

This soil is suited to most crops grown in the survey area if drainage is adequate. It is used mainly for corn, oats, soybeans, sorghum, alfalfa, and tame grasses. It is better suited to late-planted crops, such as corn and sorghum, than to spring-sown crops, such as oats or other small grain. Alfalfa grows poorly if drainage is inadequate.

Installing and maintaining surface drains helps to remove excess water. The use of diversions and other practices that reduce runoff from adjacent soils also help to reduce wetness. Returning crop residue to the soil, tilling at the proper time, and applying manure help to maintain tilth.

CAPABILITY UNIT IIIw–4

This unit consists of deep, poorly drained and somewhat poorly drained, nearly level soils on bottom lands and along poorly defined drainageways on uplands. In most of these soils, the surface layer is fine sandy loam and loam, but in places it is sandy loam, loam, or silt loam.

These soils have medium fertility and moderate organic-matter content. The available water capacity is moderate or high. Permeability is moderately rapid. Runoff is slow. Fieldwork is delayed in some years because of wetness resulting from flooding or from a seasonal high water table. In most years, however, drainage is adequate for crops. These soils blow easily, and the high content of lime in some of these soils affects crop growth. Controlling wetness and soil blowing and maintaining or improving fertility are main concerns of management. Maintaining organic-matter content is also an important concern.

These soils are moderately well suited to most crops grown in the survey area. Corn, oats, sorghum, soybeans, and alfalfa are the main crops. These soils are better suited to late-seeded crops, such as corn and sorghum, than to spring-sown small grain.

Installing and maintaining surface or subsurface drains helps to remove excess water and to regulate the water table level. Returning crop residue to the soil helps to control soil blowing. Applying chemical fertilizer and manure helps to maintain or improve fertility and organic-matter content.

CAPABILITY UNIT IIIs–1

Henkin fine sandy loam, 0 to 2 percent slopes, is the only soil in this unit. It is a deep, well drained, and nearly level soil on uplands.

This soil has medium fertility and moderate organic-matter content. The available water capacity is moderate or high. Permeability is moderately rapid. Runoff is slow, and the hazard of erosion is slight. This soil is subject to soil blowing and is somewhat droughty. Controlling soil blowing and conserving moisture are the main concerns of management. Maintaining fertility and organic-matter content is also an important concern.

This soil is moderately well suited to most crops grown in the survey area. It is used mainly for corn, oats, sorghum, soybeans, and alfalfa. In dry years, it is better suited to small grain and sorghum than to corn and soybeans.

Returning crop residue to the soil, wind stripcropping, minimum tillage, and field windbreaks help to control soil blowing and to conserve moisture. Using grasses and legumes in the cropping system and applying chemical fertilizer and manure help to maintain fertility and organic-matter content.

CAPABILITY UNIT IIIs–3

Delmont loam, 0 to 3 percent slopes, is the only soil in this unit. This soil is somewhat excessively drained and nearly level to gently undulating and is shallow over gravelly sand.

This soil has medium fertility and moderate organic-matter content. Because the available water capacity is low, the soil is droughty. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. Runoff is slow to medium. Conserving moisture and controlling soil blowing are the main concerns of management. Maintaining fertility and organic-matter content is also an important concern.

Corn, oats, sorghum, alfalfa, and tame grasses are the main crops. This soil is better suited to small grain, sorghum, and tame grasses than to corn, soybeans, and alfalfa.

Returning crop residue to the soil, including close-sown crops and tame grasses in the cropping system, and minimum tillage help to conserve moisture and to control soil blowing. Applying manure helps to maintain fertility and organic-matter content.

CAPABILITY UNIT IVe–1

The Egan part of Egan-Betts complex, 3 to 9 percent slopes, eroded, is the only soil in this unit. This is a deep, well drained, and gently sloping to moderately sloping soil on uplands. It is moderately eroded. It has a surface layer of silt loam or silty clay loam.

This soil has medium fertility and moderate organic-matter content. Erosion has lowered the natural fertility. The available water capacity is high. Permeability is moderate in the subsoil. Runoff is medium, and the erosion hazard is severe. Controlling erosion is the main concern of management. Maintaining or improving fertility and organic-matter content is also an important concern.

This soil is moderately well suited to all crops grown in the survey area. It is used mainly for corn, oats, sorghum, alfalfa, and tame grasses. Unless further erosion is controlled, it is better suited to small grain, alfalfa, and tame grasses than to row crops.

Including close-sown crops in the cropping system and using crop residue, contour farming, terracing, grassed waterways, and minimum tillage help to control erosion. Using grasses and legumes in the cropping system, using green manure crops, and applying chemical fertilizer and manure help to maintain or improve fertility and organic-matter content.

CAPABILITY UNIT IVe–2

This unit consists of deep, well drained, gently rolling soils on uplands. These soils have a loam surface

layer. In cultivated areas the surface layer is calcareous, and in places the soils are moderately eroded.

These soils have medium to low fertility and moderately low to low organic-matter content. The available water capacity is high. Permeability is moderate in the subsoil and moderately slow in the underlying glacial till. Runoff is medium, and the hazard of erosion is severe. Controlling erosion and improving fertility and organic-matter content are the main concerns of management.

These soils are moderately well suited to most crops grown in the survey area. They are better suited to small grain, alfalfa, and tame grasses than to row crops because of the hazard of erosion.

Including close-sown crops, grasses, and legumes in the cropping system and using crop residue, grassed waterways, and minimum tillage help to control erosion. In most areas slopes are too short and irregular for contour farming and terracing. Using green manure crops and applying chemical fertilizer and manure help to improve fertility and organic-matter content.

CAPABILITY UNIT IVe–3

Henkin variant fine sandy loam, 0 to 6 percent slopes, is the only soil in this unit. This is a well drained and nearly level to undulating soil that is moderately deep over gravel and sand.

This soil has medium fertility and moderate organic-matter content. Because the available water capacity is low, the soil is droughty. Permeability is moderately rapid in the subsoil and rapid in the underlying gravel and sand. Runoff is slow. The hazard of erosion is slight, but this soil blows easily. Controlling soil blowing and conserving moisture are the main concerns of management. Maintaining fertility and organic-matter content is also an important concern.

Corn, oats, sorghum, and alfalfa are the main crops. This soil is better suited to small grain and tame grasses than to deep-rooted crops such as corn and alfalfa.

Returning crop residue to the soil, including close-sown crops in the cropping system, wind stripcropping, minimum tillage, and field windbreaks are among the practices that help to control soil blowing and to conserve moisture. Applying chemical fertilizer and manure helps to maintain fertility and organic-matter content.

CAPABILITY UNIT IVw–2

This unit consists of deep, somewhat poorly drained to very poorly drained, nearly level and level soils on bottom lands and in closed depressions. Most of these soils have a surface layer of loam, silty clay loam, or silty clay. Some of these soils have concentrations of salts in the upper 15 inches.

These soils have medium to high fertility and moderate to high organic-matter content. Runoff is slow to ponded. Farming commonly is delayed because of wetness resulting from flooding and a high water table. Crops are subject to drowning in wet years. Most of these soils compact and lose their tilth if farmed when wet. Wetness is the main concern of management. Maintaining fertility and tilth is also an important concern.

These soils are poorly suited to crops. They are better suited to alfalfa, tame grasses, and late-planted crops than to small grain. Some of the soils are poorly suited to late-planted row crops because of a high content of salts.

Installing and maintaining surface drains help to remove excess water and regulate the level of the water table of some of the soils on bottom lands. Drainage usually is not feasible on the soils in depressions because adequate outlets are not available. The use of crop residue, applying manure, and timely tillage help to maintain fertility and tilth.

CAPABILITY UNIT IVs–2

Delmont loam, 3 to 6 percent slopes, is the only soil in this unit. This soil is somewhat excessively drained and undulating and is shallow over gravelly sand.

This soil has medium fertility and moderate organic-matter content. The available water capacity is low, and the soil is droughty. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. Runoff is medium, and the hazards of erosion and soil blowing are moderate. Conserving moisture and controlling erosion and soil blowing are the main concerns of management.

This soil is poorly suited for crops. It is used mainly for corn, oats, sorghum, alfalfa, and tame grasses. It is better suited to small grain and tame grasses than to deep-rooted crops such as corn and alfalfa.

The use of crop residue, including close-sown crops and tame grasses in the cropping system, and minimum tillage help to conserve moisture and to control soil blowing and erosion. Slopes in most areas are too short and irregular for contour farming. Applying manure helps to maintain fertility and organic-matter content.

CAPABILITY UNIT IVs–3

The Dudley part of Dudley-Stickney complex, 0 to 2 percent slopes, is the only soil in this unit. This soil is deep, moderately well drained, and nearly level. It has a surface layer of silt loam and a claypan subsoil.

This soil has medium fertility; the sodium-affected subsoil takes in water slowly and releases it slowly to plant roots. This soil is droughty late in summer, but it dries slowly in spring and loses its tilth if farmed when wet. Runoff is slow. Improving the water intake rate and maintaining tilth are the main concerns of management. Maintaining fertility and the organic-matter content is also an important concern.

This soil is moderately well suited to most crops grown in the survey area. Corn, oats, sorghum, soybeans, alfalfa, and tame grasses are the main crops. This soil is better suited to early-maturing and drought-resistant crops, including small grain and sorghum, than to corn and soybeans.

The use of crop residue, grasses and legumes in the cropping system, chiselling or subsoiling, and timely tillage help to improve the water intake rate, to conserve moisture, and to maintain tilth and fertility. Applying chemical fertilizer and manure also helps to maintain fertility, organic-matter content, and tilth.

CAPABILITY UNIT Vw–2

This unit consists of undrained areas of Worthing silty clay loam. This soil is deep and very poorly drained and is in closed depressions.

Runoff is ponded, and water is at or near the surface during most of the growing season. Because drainage is not feasible, the areas are not suited to cultivation.

This soil is well suited to hay crops and pasture and to wildlife habitat.

CAPABILITY UNIT VIe-3

This unit consists of deep, well drained, undulating to hilly soils on uplands. These soils have a surface layer of loam. In cultivated areas the soils are moderately to severely eroded and are calcareous at the surface.

These soils have medium to low fertility and moderately low to low organic-matter content. The available water capacity is high. Permeability is moderate in the subsoil and moderately slow in the underlying material. Runoff is medium to rapid. Controlling erosion is the main concern of management.

These soils are not suited to cultivation because the hazard of erosion is very severe. They are better suited to pasture and hay crops. Seeding cultivated areas to grass and proper grazing use help to control erosion.

CAPABILITY UNIT VIe-6

This unit consists of somewhat excessively drained and excessively drained, undulating to rolling soils that are shallow or very shallow over gravelly sand. Some of these soils are underlain by hard bedrock, generally at a depth of 20 to 40 inches.

These soils have medium to low fertility and moderate to moderately low organic-matter content. The available water capacity is low. Permeability is rapid in the underlying gravelly sand. Runoff is medium to slow, and the hazards of soil blowing and erosion are severe if the plant cover is removed. Controlling erosion and soil blowing is the main concern of management. Conserving moisture is also an important concern.

These soils are poorly suited to crops. Almost all areas remain in native grass and are used for grazing.

Seeding cultivated areas to grass and proper grazing use help to control soil blowing and erosion and to conserve moisture.

CAPABILITY UNIT VIw-1

Chaska soils, channeled, are the only soils in this unit. They are deep, poorly drained, nearly level soils on bottom lands. They have a surface layer of silt loam, loam, or very fine sandy loam.

These soils are frequently flooded and have a high water table. Because areas are long and narrow and mostly dissected by meandering stream channels, farming is impractical. Wetness is the main concern of management.

Most areas remain in native vegetation. These soils are better suited to hay crops, pasture, and wildlife habitat. Damage from flooding is minor if the soils are kept in permanent vegetation.

CAPABILITY UNIT VIw-3

Durrstein silt loam is the only soil in this unit. This soil is deep, poorly drained, and nearly level. It has a thin surface layer overlying a claypan.

This soil has low fertility and poor tilth. Runoff is slow, and water ponds in low areas. The claypan absorbs water very slowly and releases it slowly to plants. In addition, the high content of salts affects crop growth.

This soil generally is not suited to cultivation because of wetness caused by a seasonal high water table and because it has poor tilth and a high content of sodium and other salts. Proper grazing use helps to maintain the desirable forage plants.

CAPABILITY UNIT VIIe-1

The Betts part of Betts and Ethan loams, 15 to 40 percent slopes, is the only soil in this unit. This is a deep, excessively drained, and hilly to steep soil on uplands.

This soil has low fertility and organic-matter content. The available water capacity is high. Runoff is rapid, and the hazard of erosion is very severe if the plant cover is removed. Controlling erosion is the main concern of management.

This soil is too steep and erodible for cultivation. It is better suited to native pasture. Proper grazing use helps to control erosion.

CAPABILITY UNIT VIIIs-1

This unit consists only of the Rock outcrop part of Delmont-Rock outcrop complex, 2 to 9 percent slopes. Rock outcrop consists of hard quartzite bedrock. In some areas it is exposed at the surface, and in other areas it consists of ledges up to 15 feet thick on the sides of drainageways or on low escarpments.

Areas of Rock outcrop support little or no vegetation, although they have some potential as a source of material for construction use.

Management of Tame Pastures [3]

Tame pasture is a practical, economically feasible land use for most soils in this survey area. About 21,000 acres in the survey area are in permanent tame pasture and hayland. In addition, a significant acreage of cropland periodically is seeded to tame grasses for use as rotation pasture and hay in the cropping system.

The primary objective of pasture management is to maintain vigorous stands of well adapted plants that will provide palatable forage for livestock and also will improve the soil and control erosion and soil blowing. Management that controls grazing and provides adequate soil fertility, clipping, and weed control helps to meet these objectives.

Proper grazing use includes delaying grazing until vegetation has a good start in spring, not grazing too closely, rotation grazing, and grazing at the optimum stage of growth. Maintaining adequate fertility includes the application of fertilizer when needed and maintaining an adequate supply of all plant nutrients. Clipping usually helps to distribute grazing and stimulate an even regrowth. If stands are thin, controlling weeds by mowing or spraying results in a larger supply of available moisture and plant nutrients for desirable species.

The soils in this survey area that are suitable for tame pasture have been placed into pasture suitability groups. The soils within each pasture group have the

[3] By PAUL M. BODEN, conservation agronomist, Soil Conservation Service.

ability to produce about the same kind and amount of tame grasses and legumes. These groups are described in the following paragraphs. To find the pasture suitability group for a given soil, refer to the "Guide to Mapping Units" at the back of this survey.

PASTURE GROUP A

This group consists of deep, somewhat poorly drained and poorly drained soils on bottom lands and in low areas on uplands. These soils are subject to flooding or have a high water table within the rooting zone of pasture plants, or both. Natural drainage is adequate for adapted grasses and legumes, or artificial drainage has been provided.

All climatically adapted grasses and legumes are suited to this soil, but only plants capable of utilizing excessive amounts of moisture are recommended. Suitable grasses and legumes are alfalfa, big bluestem, creeping foxtail, indiangrass, intermediate wheatgrass, reed canarygrass, smooth bromegrass, and switchgrass.

PASTURE GROUP B

This group consists of deep, somewhat poorly drained to very poorly drained soils on bottom lands in low areas on uplands. These soils are frequently flooded or have a high water table within the rooting zone throughout the growing season. They are not artificially drained, and installing a drainage system is not feasible on most soils because of the lack of outlets.

Excess moisture limits the choice of plants to creeping foxtail, reed canarygrass, western wheatgrass, and other water-tolerant plants.

PASTURE GROUP C

The only soil in this group is the Dudley part of Dudley-Stickney complex, 0 to 2 percent slopes. This soil is deep and moderately well drained; it has a claypan subsoil. The claypan absorbs water slowly and limits the growth of plant roots. Slow to very slow permeability and the high sodium content of the subsoil or underlying material limit the choice of plants and production of forage.

Suitable grasses and legumes are alfalfa, crested wheatgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and western wheatgrass.

PASTURE GROUP D

This group consists of loamy soils that are shallow to moderately deep over gravelly sand or gravel and sand. Most of these soils are well drained to somewhat excessively drained. One of the soils, however, is somewhat poorly drained because it has a seasonal high water table. Permeability is rapid in the underlying gravelly sand. The available water capacity is low or moderate, and the soils are droughty or somewhat droughty. The low available water capacity limits the choice of plants and results in low yields.

Suitable species for those soils that are shallow over gravelly sand are crested wheatgrass and pubescent wheatgrass. For the soils that are moderately deep over gravelly sand, alfalfa, intermediate wheatgrass, and smooth bromegrass are suitable.

PASTURE GROUP E

This group consists of deep, moderately well drained soils on uplands. They have a thick surface layer and a somewhat restrictive claypan that absorbs water slowly and releases it slowly to plant roots. The claypan and the high sodium content of the subsoil or underlying material affect root growth and limit forage production.

Suitable grasses and legumes are alfalfa, big bluestem, green needlegrass, indiangrass, intermediate wheatgrass, smooth bromegrass, and switchgrass.

PASTURE GROUP F

This group consists of deep, well drained and moderately well drained, loamy and silty soils on uplands. Permeability is moderate or moderately slow in the subsoil. The available water capacity of the soils is mostly high.

These soils are well suited to all climatically adapted pasture plants, but erosion is a hazard if bunch-type species are planted alone on slopes of 6 percent or more. Suitable grasses and legumes are alfalfa, big bluestem, green needlegrass, indiangrass, intermediate wheatgrass, smooth bromegrass, and switchgrass.

PASTURE GROUP G

This group consists of deep and moderately deep, well drained, loamy and silty soils on uplands. These soils are calcareous at a depth of 9 inches or less. Because these soils have medium to low fertility and a high content of lime and erosion is a severe to very severe hazard, the choice of plants and amount of forage production are limited.

Suitable grasses and legumes are alfalfa, intermediate wheatgrass, and smooth bromegrass.

PASTURE GROUP H

This group consists of deep, well drained soils on uplands. These soils have a surface layer of fine sandy loam. Permeability is moderately rapid. The available water capacity is moderate or high, but the soils are somewhat droughty. Forage production is limited by droughtiness and the severe hazard of soil blowing.

Suitable grasses and legumes are alfalfa, big bluestem, indiangrass, intermediate wheatgrass, smooth bromegrass, and switchgrass.

PASTURE GROUP J

This group consists of deep, poorly drained and very poorly drained soils on bottom lands and along drainageways on uplands. These soils have a high content of salts and have a water table at or near the surface during part of the growing season. Salinity and wetness severely limit the choice of plants.

Suitable grasses are tall wheatgrass and western wheatgrass.

PASTURE GROUP K

This group consists of deep, moderately well drained soils in swales, on foot slopes and fans, and on bottom lands of small streams. Fertility and available water capacity are high. These soils commonly receive additional moisture as runoff from adjacent soils, which is beneficial to pasture plants. Forage production gener-

ally is higher than on adjacent uplands. These soils are well suited to all climatically adapted pasture plants.

Suitable grasses and legumes are alfalfa, big bluestem, creeping foxtail, indiangrass, intermediate wheatgrass, reed canarygrass, smooth bromegrass, and switchgrass.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 2. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 2.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 2 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Range [4]

Before it was settled, the survey area was covered mostly by prairie vegetation. Some trees grew along the James River and in scattered places along creeks and around lakes.

As the area was settled, much of the grassland was cultivated. Generally the soils least subject to erosion were selected for cultivation. As a result, the soils remaining in native vegetation are mostly steep, shallow, stony, or wet, or they have other characteristics that make them less suitable for cultivation.

About 141,000 acres, or 18 percent of the land, is native grassland. Much of this acreage is on hilly to steep Betts and Ethan soils in the Ethan-Betts-Chaska association. These soils are poorly suited to cultivation. Other small tracts of native grassland are intermingled with larger areas of cropland.

Because much of the rangeland has been heavily grazed for a long time, there have been changes in the plant cover. Nevertheless, by using range site groupings and range condition classes, the potential production of the soils can be estimated.

Range sites and condition classes

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its potential to produce native plants. It is the product of all environmental factors responsible for its development. In the absence of abnormal disturbance and physical deterioration of the site, it supports a plant community that differs from that on other range sites in the kind or proportion of species or in total annual yield. Boundaries of the range sites can be determined directly from the detailed soil maps at the back of this survey.

Range condition is the state of the present vegetation in relation to the climax plant community for that site (*3*). The terms *climax* and *natural potential* are considered to be synonymous.

Range condition classes, expressed in percent, indicate the degree to which the present composition has departed from the climax plant community on a range site.

Four range condition classes are recognized: excellent, good, fair, and poor. A range is in *excellent* condition if 76 to 100 percent of the vegetation is the climax vegetation for that site. It is in *good* condition if the percentage is 51 to 75, in *fair* condition if the percentage is 26 to 50, and in *poor* condition if the percentage is 25 or less.

The determination of range condition provides a basis for predicting the nature and direction of plant community changes that can be expected from management and treatment.

A range condition guide for each site is used to help determine the range condition of native grassland pasture. Range plants on each site are classified according to their response to grazing as *decreasers*, *increasers*, or *invaders*.

Decreasers are species in the climax plant community that decrease in relative abundance if the site is subjected to continued excessive grazing. *Increasers* are species in the climax plant community that increase if the site is subjected to continued excessive grazing. *Invaders* are not members of the climax plant community for the site. They invade the community as a result of various kinds of disturbance.

Description of range sites

The soils in this survey area are grouped into 11 range sites, which are described in the following paragraphs. Each description includes important character-

[4] By C. M. SCUMACHER, range conservationist, Soil Conservation Service.

TABLE 2.—*Estimated yields per acre of crops and pasture*

[Yields are for a high level of management. Absence of a figure indicates the crop is seldom grown on the soil or the soil is not suited to the crop]

Soil series and map symbols	Corn	Oats	Alfalfa hay	Soybeans	Grain sorghum	Bromegrass-alfalfa
	Bu	*Bu*	*Ton*	*Bu*	*Bu*	*AUM* [1]
Betts: BeE [2]						
Bon: Bo	95	82	4.1	39	73	6.9
Chaska:						
Ca [2]	85	75	4.0	34	72	6.6
Cb [2]						
Clamo: Cc	70	56	3.8	30	56	6.2
Clarno:						
CdA	76	76	3.1	28	59	5.2
CdB	72	75	3.1	27	54	5.2
CeA [2]	72	73	3.0	25	56	5.0
CeB [2]	68	71	2.9	24	52	4.8
CnC [2]	59	61	2.9	21	44	4.7
CsA [2]	73	72	3.0	25	55	5.0
Crossplain: Ct [2]	65	65	3.5	25	56	5.9
Davis:						
DaB	85	83	3.9	30	75	6.5
DaC	82	80	3.7	26	71	6.1
Davison:						
DbA [2]	62	67	2.7	18	49	4.5
DcB [2]	59	65	2.8		53	4.6
Delmont:						
DeA	35	43	1.7	16	28	2.8
DeB	32	39	1.6	13	25	2.7
DmB, [2] DnD [2]						
Dimo: Do	58	72	2.4	27	45	4.0
Dudley: DsA [2]	50	51	2.3	21	39	3.8
Durrstein: Du						
Egan:						
EaC	69	67	3.2	26	61	5.3
EbC2 [2]	55	57	2.5	22	52	4.1
EgB [2]	80	80	3.6	30	72	6.0
Enet: EnA	54	62	2.5	27	41	4.2
Ethan:						
EtB [2]	53	58	2.7	19	41	4.5
EtC2 [2]	42	43	2.2	16	29	3.7
EtD [2]						
EuB [2]	65	69	2.8	24	45	4.6
EuC [2]	56	59	2.7	20	44	4.5
EwC [2]	52	54	2.7		39	4.5

See footnotes at end of table.

TABLE 2.—*Estimated yields per acre of crops and pasture*—Continued

Soil series and map symbols	Corn	Oats	Alfalfa hay	Soybeans	Grain sorghum	Bromegrass-alfalfa
	Bu	*Bu*	*Ton*	*Bu*	*Bu*	*AUM* [1]
Fedora: Fa [2]	59	49	2.6	16	45	4.3
Hand:						
HaA	65	68	2.6	27	55	4.3
HaB	62	65	2.5	25	54	4.2
HaC	55	60	2.3	23	49	3.8
HbC [2]	50	54	2.2	18	42	3.8
HcA [2]	71	71	2.9	28	60	4.8
HdB [2]	61	63	2.3	22	49	3.8
Henkin:						
HmA	57	54	2.5	19	45	4.2
HmB	54	52	2.3	18	42	3.8
Henkin variant: HnB	38	45	1.6	17	43	2.6
Homme:						
HoC [2]	52	55	2.8		41	4.6
HtA [2]	70	71	3.2		58	5.3
HtB [2]	64	66	2.9		57	4.8
James: Ja	30	35	2.6		30	4.0
Lamo:						
La	85	73	4.1	30	67	6.9
Lm [2]						
Marsh: Ma. Properties are too variable for yields to be estimated.						
Onita: OaA	75	75	3.3		70	5.2
Prosper:						
PcA [2]	77	81	3.4	29	64	5.5
Pr [2]	73	77	3.0	29	59	5.5
Ps [2]	77	80	3.5	29	66	5.8
Redstoe: ReB	44	54	1.9			3.0
Salmo: Sa	40	47	2.6			4.3
Storla variant: St	42	44	2.5		39	4.2
Tetonka:						
Te	62	62	3.4	26	48	5.6
Tt [2]	61	60	3.4	25	45	5.6
Tw [2]	70	55	3.4	27	51	5.6
Wann: Wa	65	46	3.5	27	56	5.8
Worthing: Ww	62	68	3.0	24	48	5.0

[1] Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

[2] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

istics of the site, principal plants, and estimated forage yields. The estimates are for range in excellent condition. They represent the total annual yield, 70 to 90 percent of which consists of grasses that are the major source of forage for cattle. To find the range site in which a soil is placed, refer to the "Guide to Mapping Units" at the back of this survey.

WETLAND RANGE SITE

This site consists of deep, poorly drained and very poorly drained soils. The water table is at or near the surface during much of the growing season. Soils in this range site are too wet and too poorly aerated to grow big bluestem, but they have the potential to produce a luxuriant stand of water-tolerant grasses.

Prairie cordgrass, reedgrass, and reed canarygrass are the main species in the climax plant cover. Slough sedge makes up about 15 percent of the vegetation in places. Shrubs and trees, such as indigobush amorpha and willows, are growing in some areas.

The stand of climax grasses loses vigor and thins out if overgrazed, and sedges, rushes, saltgrass, Kentucky bluegrass, and western wheatgrass increase. Because these plants are either shorter or less palatable than the climax plants, the loss in productivity is great. Mechanical treatment for range improvement is not feasible, and range seeding is difficult because of wetness.

If this site is in excellent condition, the total annual air-dry yield ranges from 6,000 pounds of herbage per acre in an unfavorable year to 7,000 in a favorable year.

SUBIRRIGATED RANGE SITE

This site consists of deep, poorly drained and somewhat poorly drained soils that have a water table. The water table is near the surface early in the growing season and within a depth of 6 feet during most of the growing season. The additional moisture is beneficial. These soils are sufficiently aerated to grow big bluestem. They have the potential to produce a luxuriant stand of tall prairie grasses.

Big bluestem is the dominant grass in the climax plant cover and makes up 60 to 90 percent of the vegetation in places. Other tall grasses on the site are Canada wildrye, indiangrass, prairie cordgrass, and switchgrass. Western wheatgrass and saltgrass are increasers that are present in small amounts. Kentucky bluegrass, sedges, forbs, and indigobush amorpha in some places are also on the site.

If the climax grasses are overgrazed, they lose vigor and thin out and western wheatgrass, saltgrass, and Kentucky bluegrass increase. If overgrazing continues, Kentucky bluegrass or saltgrass and an overstory of unpalatable weeds eventually dominate the site. Mechanical treatment, for example, contour furrowing and pitting, is not feasible on this site.

If this site is in excellent condition, the total annual air-dry yield ranges from 5,000 pounds of herbage per acre in an unfavorable year to 6,400 in a favorable year.

OVERFLOW RANGE SITE

This site consists mostly of moderately well drained and somewhat poorly drained soils that regularly receive moisture from stream flooding or as runoff from adjacent soils. Some of these soils have a perched water table early in the growing season. The additional moisture enables this site to produce luxuriant stands of tall grasses.

Big bluestem is the dominant grass in the climax plant cover and makes up 50 to 85 percent of the vegetation in places. Green needlegrass and porcupinegrass are abundant in a few places but not dominant. Canada wildrye, indiangrass, little bluestem, and switchgrass are other decreasers that occur in small amounts. The principal increasers are western wheatgrass and sideoats grama. Other understory plants are Kentucky bluegrass, sedges, and forbs. Leadplant amorpha is scattered in some areas.

If the climax grasses are overgrazed, they lose vigor and thin out and western wheatgrass and Kentucky bluegrass increase. If overgrazing is continued, Kentucky bluegrass will eventually dominate the site.

If this site is in excellent condition, the total annual air-dry yield of herbage ranges from 3,800 pounds per acre in an unfavorable year to 5,200 in a favorable year.

SALINE LOWLAND RANGE SITE

This site consists of deep, poorly drained and very poorly drained soils that have a water table within a depth of 6 feet during most of the growing season. These soils have concentrations of salts near the surface that affect the kinds of plants on the site.

The climax plant cover mainly consists of tall, salt-tolerant grasses. The dominant grass is alkali cordgrass or prairie cordgrass. Other tall grasses are switchgrass and alkali sacaton. Mid-grass decreasers are western wheatgrass and nuttall alkaligrass. Saltgrass is the main increaser. There are small amounts of sedges and forbs.

The climax grasses lose vigor and are replaced by saltgrass if overgrazed. If overgrazing continues, saltgrass eventually dominates the site.

If this site is in excellent condition, the total annual air-dry yield ranges from 3,600 pounds of herbage per acre in an unfavorable year to 5,000 in a favorable year.

SILTY RANGE SITE

This site consists mainly of deep, well drained and moderately well drained, loamy and silty soils on uplands. The available water capacity is high or moderate. Permeability in the subsoil is moderate or moderately slow.

A mixture of tall and mid grasses that is characteristic of the transitional areas between true prairie and mixed prairie makes up the climax plant cover. Big bluestem and little bluestem are important warm-season decreasers. Green needlegrass and western wheatgrass are of major importance but do not dominate the site. Significant amounts of blue grama, needleandthread, and sideoats grama also occur. Forbs and woody plants such as leadplant amorpha generally are not abundant but are an important part of the climax vegetation.

The bluestem species decrease and are replaced by western wheatgrass and needleandthread if over-

grazed. If overgrazing continues, western wheatgrass is replaced by blue grama.

If this site is in excellent condition, the total annual air-dry yield ranges from 2,500 pounds of herbage per acre in an unfavorable year to 4,000 in a favorable year.

SANDY RANGE SITE

This site consists of deep, well drained soils on uplands. These soils have a surface layer of fine sandy loam and a subsoil of fine sandy loam to gravelly loamy sand. Permeability is moderately rapid in the subsoil. The available water capacity is low to high.

The climax plant cover mainly consists of a mixture of mid and tall warm-season grasses. Little bluestem, sand bluestem, and big bluestem are the main species. Canada wildrye and prairie junegrass are cool-season decreasers that occur in small amounts. Prairie sandreed is the principal increaser. Needleandthread and western wheatgrass are cool-season increasers that are next in abundance. There are small amounts of blue grama, sideoats grama, and forbs.

The bluestem species decrease and are replaced by prairie sandreed, needleandthread, western wheatgrass, and sideoats grama if overgrazed. If overgrazing continues, these species are replaced by Kentucky bluegrass and blue grama.

If this site is in excellent condition, the total annual air-dry yield ranges from 2,400 pounds of herbage per acre in an unfavorable year to 3,800 pounds in a favorable year.

CLAYEY RANGE SITE

This site consists of deep, moderately well drained soils. These soils have a thick surface layer overlying a claypan. The available water capacity is high, but permeability is slow. The claypan releases moisture slowly to plants and somewhat limits their root growth.

A mixture of tall, mid, and short grasses makes up the climax plant cover. Western wheatgrass and green needlegrass are the dominant grasses. Big bluestem and little bluestem are warm-season decreasers that are present in smaller amounts. The understory is short grasses, mainly blue grama. Forbs and woody plants are of little importance.

Green needlegrass and the bluestems are replaced by western wheatgrass if the site is overgrazed. If overgrazing continues, the western wheatgrass is replaced by short grasses.

If this site is in excellent condition, the total annual air-dry yield ranges from 2,400 pounds of herbage per acre in an unfavorable year to 3,700 pounds in a favorable year.

THIN UPLAND RANGE SITE

This site consists of deep, well drained to excessively drained, loamy and silty soils on uplands. These soils are calcareous at or near the surface and have low or medium fertility. The available water capacity is low to high. Runoff is medium to rapid, and much of the precipitation is lost by runoff.

Little bluestem is of major importance in the climax plant cover. Other important decreasers are big bluestem and green needlegrass. Sideoats grama, western wheatgrass, needleandthread, and blue grama are the important increasers. Forbs and shrubs, such as leadplant amorpha, are important in places.

The bluestem species and green needlegrass are replaced by needleandthread and sideoats grama if the site is overgrazed. If overgrazing continues, blue grama eventually dominates the site.

If this site is in excellent condition, the total annual air-dry yield ranges from 2,300 pounds of herbage per acre in an unfavorable year to 3,600 in a favorable year.

CLAYPAN RANGE SITE

The Dudley part of Dudley-Stickney complex, 0 to 2 percent slopes, is the only soil in this site. This soil is deep and moderately well drained. It has a claypan subsoil that releases moisture slowly and limits the root growth of plants. The available water capacity is moderate or high, but permeability is slow or very slow.

Western wheatgrass is dominant in the climax plant cover. Significant amounts of switchgrass and green needlegrass are in the plant community, but growth is poorer than on other sites. Blue grama, sedges, and forbs are an important part of the plant cover. Small amounts of saltgrass grow in places.

Green needlegrass and tall grasses are replaced by western wheatgrass and blue grama if this site is overgrazed. If overgrazing continues, blue grama and other short grasses eventually dominate the site during dry periods and are overtopped by weeds during wet cycles.

If this site is in excellent condition, the total annual air-dry yield ranges from 2,100 pounds of herbage per acre in an unfavorable year to 3,400 in a favorable year.

SHALLOW TO GRAVEL RANGE SITE

This site consists of somewhat excessively drained, loamy soils that are shallow over gravelly sand. The available water capacity is low, and the soil is droughty.

A mixture of mid and short grasses makes up the climax plant cover. Needleandthread, sideoats grama, and little bluestem are the important mid grasses. Blue grama, hairy grama, and threadleaf sedge are important short-growing plants. Forbs, such as blacksamson, are common.

The short grasses, along with a few unpalatable weeds as an overstory, become dominant if the site is overgrazed. Mechanical treatment, such as contour furrowing and pitting, is not feasible on this site.

If this site is in excellent condition, the total annual air-dry yield ranges from 1,700 pounds of herbage per acre in an unfavorable year to 3,000 in a favorable year.

VERY SHALLOW RANGE SITE

The Talmo part of Delmont-Talmo complex, 6 to 12 percent slopes, is the only soil in this site. This soil is excessively drained and loamy and is very shallow over gravelly sand. The available water capacity is low, and the soil is very droughty. Permeability is rapid.

A mixture of mid and short grasses makes up the climax plant cover. Needleandthread, sideoats grama, and little bluestem are the important mid grasses. Blue

grama and threadleaf sedge are important short-growing plants.

This site rapidly deteriorates to a stand of blue grama and threadleaf sedge if overgrazed. If overgrazing continues, the plant cover is thinned, leaving bare areas of soil susceptible to erosion. Mechanical treatment is not feasible on this site, and there is little probability that range seeding will be successful.

If this site is in excellent condition, the total annual air-dry yield ranges from 1,400 pounds of herbage per acre in an unfavorable year to 2,600 in a favorable year.

Native Woods and Windbreaks [5]

Hanson and Hutchinson Counties have approximately 5,200 acres of native woods. Most of the native trees and shrubs are on bottom lands along the James River and its principal tributaries (fig. 13).

The principal species are American elm, American plum, boxelder, bur oak, green ash, hackberry, plains cottonwood, western snowberry, and several species of wild rose and willow. The native trees and shrubs are used primarily for livestock protection, watershed protection, and wildlife habitat.

Windbreaks have been planted in the survey area since the time of the early settlers. The early plantings were mainly to protect the farmsteads and livestock, and many farmsteads still need this type of protection. In recent years, field windbreaks have been planted to help control soil blowing and to conserve moisture. Thousands of acres in the survey area still need some form of wind protection.

Windbreaks return many economic and environmental benefits to the landowner. They distribute and hold snow. They protect the home and livestock from winter winds and thus reduce fuel and feed costs. In addition, they protect field crops, gardens, and orchards from damaging winds and help to control soil blowing. They reduce moisture evaporation. They also provide a suitable habitat for birds and other wildlife. Finally, they enhance the beauty of the rural home and its surroundings (fig. 14).

The purpose of the planting, the suitability of the soils, the adaptability of trees and shrubs, and the

[5] By DAVID L. HINTZ, forester, Soil Conservation Service.

Figure 13.—Most of the native trees in the survey area are on bottom lands along the James River and its tributaries.

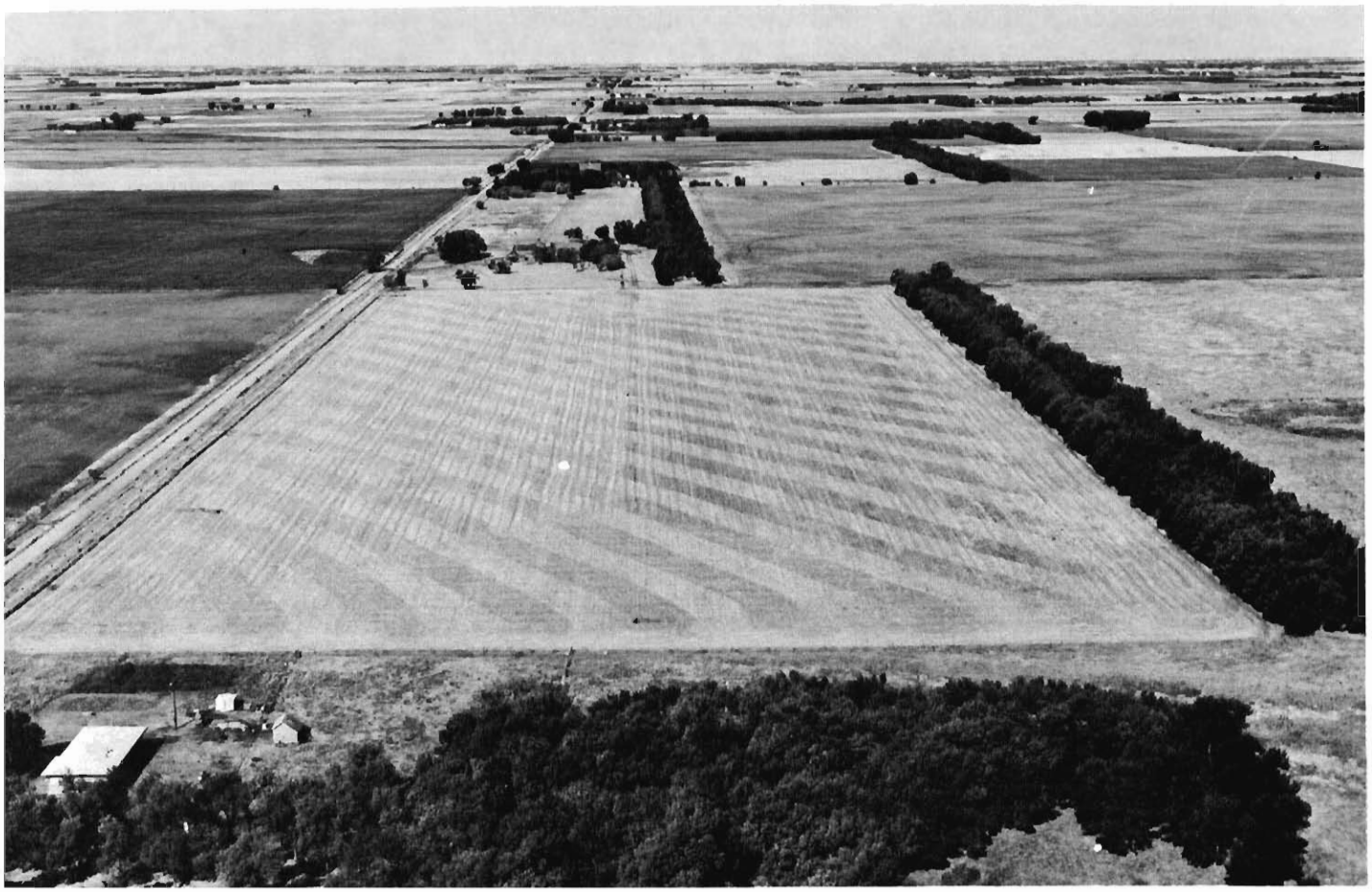

Figure 14.—Windbreaks in Hanson County on Clarno loam, 0 to 3 percent slopes.

planting site should be considered in planning a windbreak.

Establishing a windbreak and insuring continued growth of the trees requires a careful selection of the site and of the trees and shrubs to be planted, adequate site preparation before planting, and adequate maintenance after planting. Grass and weeds need to be eliminated before trees are planted, and regrowth of ground cover needs to be controlled during the life of the windbreak. Some replanting after the first or second year generally is necessary.

The soils in this survey area are placed in windbreak groups in which the growth response of adapted trees and shrubs generally is the same for all soils if proper management is used. The dominant factors in placing soils into windbreak groups are the amount of moisture available to trees and the seasonal dependability of the supply. Slope and soil texture are less critical but are also important, because they affect susceptibility to erosion and soil blowing.

Table 3 can be used as a guide in planning windbreaks. It lists the main tree and shrub species, by height class, that are suitable for each windbreak group in the survey area except group 10. The heights are based on measurements and observations made on windbreaks 20 years of age that have been adequately managed. Soils in windbreak group 10 are not suitable for windbreaks. Onsite investigation is necessary to determine which species are suited to special plantings on soils in windbreak group 10 because of the wide range of soil characteristics and site conditions.

The windbreak groups in the survey area are described in the following paragraphs. The groups are not numbered consecutively because not all the groups in the statewide system are represented in the counties. To find the windbreak group of a given soil, refer to the "Guide to Mapping Units" at the back of this survey.

WINDBREAK GROUP 1

This group consists of deep, moderately well drained, nearly level to moderately sloping soils on bottom lands, foot slopes, and fans and in swales on uplands. These soils have a surface layer of loam or silt loam. Most of these soils have high fertility and a high available water capacity. Permeability is moderate or moderately slow. These soils receive additional moisture from stream flooding and runoff from adjacent soils. Some of the soils have a perched water table early in the growing season, but this additional moisture is favorable for tree growth in most years. Most of the soils are not susceptible or are moderately susceptible to erosion and are slightly susceptible to soil blowing.

TABLE 3.—*Windbreaks and environmental plantings*

[Absence of an entry means that trees and shrubs generally do not grow to the specified height on the soils in that windbreak group]

Windbreak group and soil map symbols	Trees and shrubs having predicted 20-year average height of—				
	Less than 8 feet	8 to 15 feet	16 to 25 feet	26 to 35 feet	More than 35 feet
Group 1: Bo, DaB, DaC, DbA, OeA; Bonilla part of HcA; Davison part of CeA, CeB, DcB, and HdB; Onita part of HtA and HtB; and Prosper part of PcA, Pr, and Ps.	Common lilac, golden currant, Nanking cherry,[1] Peking cotoneaster, redosier dogwood, sandcherry,[2] Saskatoon serviceberry, and skunkbush sumac.	American plum, common chokecherry, Ginnala maple, Manchurian apricot, Siberian apricot, Siberian peashrub, silver buffaloberry, Tatarian honeysuckle, and Villosa lilac.	Boxelder, bur oak, eastern redcedar, green ash, hackberry, Harbin pear, Manchurian crabapple, Rocky Mountain juniper, Russian mulberry, Russian-olive, and Siberian crabapple.	Black Hills spruce, blue spruce, Chinkota elm, Dropmore elm, golden willow, honeylocust, ponderosa pine, Scotch pine, Siberian elm, silver maple, and white willow.	Eastern cottonwood, northwest poplar, plains cottonwood, and Siouxland cottonwood.
Group 2: Ca, Cc, Ct, Fa, La, Lm, St, Wa; Crossplain part of Ps; Harps part of Tt; and Whitewood part of Tw.	American plum, common lilac, golden currant, Nanking cherry,[1] Peking cotoneaster, redosier dogwood, Saskatoon serviceberry, silver buffaloberry, skunkbush sumac, Tatarian honeysuckle, and Villosa lilac.	Common chokecherry, eastern redcedar, Ginnala maple, Rocky Mountain juniper, and Siberian peashrub.	Black Hills spruce, blue spruce, boxelder, bur oak, green ash, hackberry, Harbin pear, Manchurian crabapple, ponderosa pine, Russian mulberry, Russian-olive, Scotch pine, and Siberian crabapple.	Eastern cottonwood, golden willow, honeylocust, plains cottonwood, silver maple, Siouxland cottonwood, and white willow.	Northwest poplar.
Group 3: CdA, CdB, Do, EaC, EgB, HaA, HaB, HaC; Clarno part of CeA, CeB, CnC, CsA, EuB, EuC, and PcA; Egan part of EbC2; Hand part of HbC, HcA, and HdB; and Homme part of EwC, HoC, HtA, and HtB.	Common lilac, golden currant, Nanking cherry,[1] Peking cotoneaster, redosier dogwood, sandcherry,[2] skunkbush sumac, and Villosa lilac.	American plum, common chokecherry, eastern redcedar, Ginnala maple, Manchurian apricot, Rocky Mountain juniper, Siberian apricot, Siberian peashrub, silver buffaloberry, and Tatarian honeysuckle.	Boxelder, bur oak, green ash, hackberry, Harbin pear, Manchurian crabapple, ponderosa pine, Russian mulberry, Russian-olive, Scotch pine, and Siberian crabapple.	Black Hills spruce, blue spruce, Chinkota elm, Dropmore elm, honeylocust, Siberian elm, and silver maple.	
Group 4: Stickney part of CsA, DsA, and Pr.	Common lilac, golden currant, Nanking cherry,[1] Peking cotoneaster, and Siberian peashrub.	American plum, common chokecherry, eastern redcedar, Harbin pear, Manchurian apricot, Manchurian crabapple, Rocky Mountain juniper, Siberian apricot, Siberian crabapple, silver buffaloberry, and Tatarian honeysuckle.	Green ash, hackberry, ponderosa pine, Russian-olive, and Scotch pine.	Honeylocust -------	Chinkota elm, Dropmore elm, and Siberian elm.
Group 5: HmA, HmB.	American plum common lilac, golden currant, Nanking cherry,[1] Peking cotoneaster, sandcherry,[2] silver buffaloberry, skunkbush sumac, and Tatarian honeysuckle.	Common chokecherry, eastern redcedar, Harbin pear, Manchurian apricot, Rocky Mountain juniper, Siberian apricot, and Siberian peashrub.	Bur oak, green ash, hackberry, Manchurian crabapple, ponderosa pine, Russian-olive, Scotch pine, and Siberian crabapple.	Chinkota elm, Dropmore elm, honeylocust, and Siberian elm.	

See footnotes at end of table.

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Windbreak group and soil map symbols	Trees and shrubs having predicted 20-year average height of—				
	Less than 8 feet	8 to 15 feet	16 to 25 feet	26 to 35 feet	More than 35 feet
Group 6: EnA, HnB--	Common lilac, Peking cotoneaster, Siberian peashrub, silver buffaloberry, and Tatarian honeysuckle.	Eastern redcedar, green ash, hackberry, Harbin pear, Manchurian crabapple, ponderosa pine, Rocky Mountain juniper, Russian-olive, Scotch pine, and Siberian crabapple.	Chinkota elm, Dropmore elm, honeylocust, and Siberian elm.		
Group 8: EtB, ReB; Betts part of HbC; and Ethan part of CnC, EuB, EuC, EwC, and HoC.	American plum, common lilac, Peking cotoneaster, Siberian peashrub, silver buffaloberry, and Tatarian honeysuckle.	Eastern redcedar, green ash, hackberry, Harbin pear, ponderosa pine, Rocky Mountain juniper, and Russian-olive.	Chinkota elm, Dropmore elm, honeylocust, and Siberian elm.		
Group 9: Dudley part of DsA.	Common lilac, eastern redcedar, Harbin pear, Rocky Mountain juniper, Siberian peashrub, and silver buffaloberry.	Chinkota elm, Dropmore elm, green ash, ponderosa pine, Russian-olive, and Siberian elm.			

[1] This species generally has a serious decline in vigor after 10 years.
[2] This species generally has a serious decline in vigor after 5 years.

Soils in this group are well suited to all kinds of windbreaks and other types of woody plantings. All climatically adapted trees and shrubs have good growth potential.

WINDBREAK GROUP 2

This group consists of somewhat poorly drained and poorly drained soils on bottom lands and in low areas on uplands. These soils have a water table within a depth of 6 feet. They have a surface layer that ranges from sandy loam to silty clay loam. Available water capacity is moderate or high in most of these soils, but it is low in one of the soils that is underlain by gravelly sand. There is no hazard or only a slight hazard of erosion, but some of the soils have a high content of lime and are moderately susceptible to soil blowing.

Soils in this group are well suited to windbreaks and other types of woody plantings. Nearly all climatically adapted species have good growth potential. Improving drainage on some of these soils helps improve growing conditions.

WINDBREAK GROUP 3

This group consists mostly of deep, well drained, nearly level to gently rolling soils on uplands. These soils have a surface layer of loam, silt loam, and silty clay loam. In most of the soils, the available water capacity is high and permeability is moderate or moderately slow. The hazard of erosion is slight to severe depending on slope. Susceptibility to soil blowing is slight or moderate.

Soils in this group are well suited to windbreaks and other types of woody plantings. All climatically adapted trees and shrubs have good growth potential except those that have high moisture requirements. Planting on the contour where the slope is 6 percent or more helps to control erosion and to conserve moisture.

WINDBREAK GROUP 4

This group consists of deep, moderately well drained, nearly level, silty soils on uplands. These soils have a claypan subsoil at a depth of about 15 inches that somewhat limits root growth of plants. The available water capacity is high, but the subsoil absorbs water slowly and releases it slowly to plants. The hazard of erosion is slight, and susceptibility to soil blowing is moderate.

Soils in this group are moderately well suited to windbreaks and other woody plantings, but they are not suited to some trees and shrubs. Many of the climatically adapted species, however, have good growth potential.

WINDBREAK GROUP 5

This group consists of deep, well drained, nearly level to undulating soils on uplands. These soils have a surface layer and subsoil of fine sandy loam. The available water capacity is moderate or high, and

permeability is moderately rapid. The hazard of soil blowing is severe. The undulating soils are moderately susceptible to erosion.

Soils in this group are well suited to windbreaks and other woody plantings. Most of the climatically adapted trees and shrubs have good growth potential except those that have high moisture requirements. Management is needed to control soil blowing before and after planting.

WINDBREAK GROUP 6

This group consists of well drained, nearly level to undulating soils that are moderately deep over gravelly sand. These soils have a surface layer of loam and fine sandy loam. Permeability is moderate or moderately rapid in the subsoil and rapid in the underlying gravelly sand. The available water capacity is moderate or low, and the soils are somewhat droughty or droughty. The hazard of erosion is slight or moderate. One of the soils is highly susceptible to soil blowing.

Soils in this group are poorly suited to windbreaks and other types of woody plantings. Windbreaks can be established if species adapted to these soils are selected and if optimum growth is not a critical requirement. Survival and vigor are poor in a dry year.

WINDBREAK GROUP 8

This group consists of deep and moderately deep, well drained, nearly level to gently rolling soils on uplands. These soils are calcareous within a depth of 9 inches. In places they are moderately to severely eroded. They have a surface layer of loam or silt loam, and the moderately deep soils are underlain by siltstone at a depth of 20 to 40 inches. Permeability is moderate. The available water capacity is high in the deep soils and low in the moderately deep soils. The hazard of erosion is moderate to severe, and the hazard of soil blowing is slight to moderate.

Soils in this group are moderately well suited to windbreaks and other woody plantings. Windbreaks can be established if species adapted to these soils are selected and if optimum survival, growth, and vigor are not required. Where the slope is 6 percent or more, planting on the contour helps to control erosion and to conserve moisture.

WINDBREAK GROUP 9

The Dudley part of Dudley-Stickney complex, 0 to 2 percent slopes, is the only soil in this group. This soil is deep and moderately well drained. It is on uplands. It has a claypan subsoil that limits root development, and its high content of sodium affects tree growth. The available water capacity is moderate or high, but permeability is slow or very slow. The hazard of erosion is slight, and the hazard of soil blowing is slight to moderate.

This soil is poorly suited to windbreaks and other woody plantings. Many species of trees and shrubs grow poorly on this soil and are not suited to windbreak plantings. Windbreaks can be established, however, if adapted species are selected and if optimum growth is not required. Survival, growth, and vigor are poor in dry years. Generally, field windbreaks on this soil are not recommended.

WINDBREAK GROUP 10

This group consists of soils that are too steep or too wet for machine plantings and soils that are too droughty, too high in salts, or too wet for the growth and survival of most trees and shrubs.

Soils in this group are not suited to windbreaks. Some of the soils can be used for other woody plantings that are planted by hand and given special care. Species of trees and shrubs should be selected that are tolerant of the conditions at a given site.

Wildlife[6]

The wildlife population of any area depends on the availability of food, cover, and water in a suitable combination. Habitat for an individual bird or animal species or group of species is created, improved, and maintained by establishing and maintaining the required combinations of vegetation for food and cover.

Table 4 rates the major soils in each of the 8 soil associations in this survey area according to their capability in producing elements of wildlife habitat appropriate to four kinds of wildlife. Each association is rated for its highest wildlife potential and for its present suitability for wildlife based on current land use. The kinds of wildlife in table 4 are described in the following paragraphs.

Farmland wildlife includes animals that frequent cropland, pastures, meadows, and planted woodland. Although these wildlife species use other areas, such as natural woodland and marshland, they are most closely associated with cultivated areas. Examples of this kind of wildlife are pheasant, gray partridge, mourning dove, cottontail, jackrabbit, fox, raccoon, and white-tailed deer.

Woodland wildlife includes animals that use sizable areas of natural woodland. These areas are bordered by and generally include farmland, rangeland, and pasture, but natural woodland is the major habitat element affecting wildlife. Planted woodland is not considered in this rating. Examples of this kind of wildlife are mule deer, white-tailed deer, cottontail, tree squirrel, raccoon, coyote, turkey, ruffed grouse, thrushes, vireos, and scarlet tanager.

Wetland wildlife includes animals that use natural wetland or improved natural wetland as all or part of their breeding habitat. Examples of this kind of wildlife are ducks, herons, shorebirds, coot, red-winged blackbird, mink, muskrat, and beaver.

Rangeland wildlife includes animals that use extensive areas of native grassland or range. Such areas generally include wooded draws and bottom land, areas of cropland, and some planted woodland. But the rangeland is the major habitat element affecting this kind of wildlife. Examples of this kind of wildlife are mule deer, white-tailed deer, antelope, jackrabbit, coyote, sharp-tailed grouse, sage grouse, prairie chicken, magpie, horned lark, lark bunting, and mourning dove.

The suitability ratings in table 4 are described as follows:

Good. Habitat can be easily established, constructed, improved, or maintained. There are few or no soil limitations, and results generally are satisfactory.

[6] By JOHN B. FARLEY, biologist, Soil Conservation Service.

TABLE 4.—*Wildlife suitability interpretations by soil association*

Soil association and percentage of major soils[1]	Suitability of the soils for—				Present land use	Highest wildlife potential
	Farmland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife		
Association 1:						
Ethan ---------25	Poor -------	Very poor --	Very poor --	Good.	Rangeland wildlife --	Rangeland wildlife.
Betts ---------20	Very poor --	Very poor --	Very poor --	Fair.		
Chaska -------20	Good -------	Poor -------	Poor -------	Fair.		
Association 2:						
Homme -------30	Good -------	Very poor --	Very poor --	Good.	Farmland wildlife ---	Farmland and rangeland wildlife.
Onita ---------15	Good -------	Very poor --	Very poor --	Good.		
Whitewood ----15	Good -------	Very poor --	Poor -------	Fair.		
Association 3:						
Egan ---------45	Good -------	Very poor --	Very poor --	Good.	Farmland wildlife ---	Farmland and rangeland wildlife.
Wentworth ----25	Good -------	Very poor --	Very poor --	Good.		
Association 4:						
Prosper -------30	Good -------	Very poor --	Very poor --	Good.	Farmland wildlife ---	Farmland and rangeland wildlife.
Clarno ---------30	Good -------	Very poor --	Very poor --	Good.		
Stickney ------10	Good -------	Very poor --	Very poor --	Good.		
Association 5:						
Clarno ---------50	Good -------	Very poor --	Very poor --	Good.	Farmland wildlife ---	Rangeland wildlife.
Tetonka -------20	Poor -------	Very poor --	Fair -------	Fair.		
Prosper -------10	Good -------	Very poor --	Poor -------	Good.		
Association 6:						
Clarno ---------35	Good -------	Very poor --	Very poor --	Good.	Farmland wildlife ---	Rangeland wildlife.
Ethan ---------15	Fair -------	Very poor --	Very poor --	Good.		
Tetonka -------15	Poor -------	Very poor --	Fair -------	Fair.		
Association 7:						
Hand ---------45	Good -------	Very poor --	Very poor --	Good.	Farmland wildlife ---	Farmland and rangeland wildlife.
Clarno ---------25	Good -------	Very poor --	Very poor --	Good.		
Davison -------15	Good -------	Very poor --	Poor -------	Good.		
Association 8:						
Crossplain ----25	Good -------	Very poor --	Poor -------	Fair.	Farmland wildlife ---	Farmland wildlife.
Clarno ---------25	Good -------	Very poor --	Very poor --	Good.		
Tetonka -------15	Poor -------	Very poor --	Fair -------	Fair.		

[1] Percentages do not total 100 because interpretations for soils of small extent are not given in the table.

Fair. Habitat generally can be established, constructed, improved, or maintained, but soil limitations affect habitat management or construction. A moderate intensity of management and frequent attention is necessary for satisfactory results.

Poor. Habitat generally can be established, constructed, improved, or maintained, but soil limitations are severe. Habitat establishment, management, or construction is generally difficult or expensive or requires intensive effort, and results are questionable.

Very poor. Natural habitat can be maintained with the use of specific management practices, but it generally is difficult or not feasible to establish, construct, or improve habitat on these soils.

Engineering[7]

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

[7] LEONARD P. KUCK, agricultural engineer, Soil Conservation Service, helped prepare this section.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 5 shows, for each kind of soil, the degree and kind of limitations for building site development; table 6, for sanitary facilities; and table 7, for water management. Table 8 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 5. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 5 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 5 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard

TABLE 5.—*Building site development*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil series and map symbols	Degree and kind of limitation for—				
	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Betts: BeE[1]	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: low strength.
Bon: Bo	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Chaska: Ca,[1] Cb[1]	Severe: wetness, floods.	Severe: wetness, floods, frost action.	Severe: wetness, floods.	Severe: wetness, floods, frost action.	Severe: wetness, floods, frost action.
Clamo: Cc	Severe: floods, wetness, too clayey.	Severe: floods, frost action, shrink-swell.	Severe: floods, frost action, shrink-swell.	Severe: floods, frost action, shrink-swell.	Severe: frost action, low strength, shrink-swell.
Clarno:					
CdA, CdB	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.	Severe: low strength.
CeA:[1]					
Clarno part	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell	Moderate: shrink-swell, frost action.	Severe: low strength.
Davison part	Severe: wetness	Severe: frost action, wetness.	Severe: wetness	Severe: frost action, wetness.	Severe: frost action.
CeB:[1]					
Clarno part	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.	Severe: low strength.
Davison part	Severe: wetness	Severe: frost action, wetness.	Severe: wetness	Severe: frost action, wetness.	Severe: frost action.
CnC[1]	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action, slope.	Severe: low strength.
CsA:[1]					
Clarno part	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.	Severe: low strength.
Stickney part	Moderate: wetness, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Crossplain:					
Ct:[1]					
Crossplain part	Severe: wetness	Severe: wetness, frost action, floods.	Severe: wetness, floods.	Severe: wetness, frost action, floods.	Severe: frost action, shrink-swell, low strength.
Harps part	Severe: wetness	Severe: wetness, low strength, frost action.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength, frost action.
Davis: DaB, DaC	Slight	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: slope, shrink-swell, frost action.	Moderate: shrink-swell, frost action, low strength.
Davison:					
DbA[1]	Severe: wetness	Severe: frost action, wetness.	Severe: wetness	Severe: frost action, wetness.	Severe: frost action.

See footnote at end of table.

TABLE 5.—*Building site development*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
DcB:[1]					
Davison part	Severe: wetness	Severe: frost action, wetness.	Severe: wetness	Severe: frost action, wetness.	Severe: frost action.
Onita part	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: slope, shrink-swell.	Severe: shrink-swell, low strength.
Delmont:					
DeA	Severe: cutbanks cave, small stones.	Slight	Slight	Slight	Slight.
DeB	Severe: cutbanks cave, small stones.	Slight	Slight	Moderate: slope.	Slight.
DmB:[1]					
Delmont part	Severe: cutbanks cave, small stones.	Slight	Slight	Moderate: slope.	Slight.
Rock outcrop part. (Too variable to be rated.)					
DnD:[1]					
Delmont part	Severe: cutbanks cave, small stones.	Slight	Slight	Moderate: slope.	Slight.
Talmo part	Severe: small stones, cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
Dimo: Do	Severe: wetness, cutbanks cave, floods.	Severe: frost action, wetness, floods.	Severe: wetness, floods.	Severe: frost action, wetness, floods.	Severe: frost action, wetness, floods.
Dudley: DsA[1]	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Durrstein: Du	Severe: floods, wetness, too clayey.	Severe: floods, shrink-swell, frost action.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, low strength.
Egan:					
EaC, EgB[1]	Slight	Severe: frost action.	Moderate: shrink-swell.	Severe: frost action.	Severe: frost action, low strength.
EbC2:[1]					
Egan part	Slight	Severe: frost action.	Moderate: shrink-swell.	Severe: frost action.	Severe: frost action, low strength.
Betts part	Moderate: too clayey.	Moderate: shrink-swell	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Enet: EnA	Severe: cutbanks cave.	Slight	Slight	Slight	Fair: low strength.
Ethan:					
EtB,[1] EtC2,[1] EuC[1]	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: slope, shrink-swell, frost action.	Severe: low strength.
EtD[1]	Moderate: slope, too clayey.	Moderate: shrink-swell, slope, frost action.	Moderate: shrink-swell, slope.	Severe: slope	Severe: low strength.

See footnote at end of table.

TABLE 5.—*Building site development*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
EuB:[1]					
Ethan part	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: slope, shrink-swell, frost action.	Severe: low strength.
Clarno part	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.	Severe: low strength.
EwC[1]					
Ethan part	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: slope, shrink-swell, frost action.	Severe: low strength.
Homme part	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Fedora: Fa[1]	Severe: wetness, cutbanks cave.	Severe: wetness, frost action.	Severe: wetness	Severe: wetness, frost action.	Severe: frost action, wetness.
Hand:					
HaA	Slight	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell, low strength, frost action.
HaB, HaC	Slight	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: slope, shrink-swell, frost action.	Moderate: shrink-swell, low strength, frost action.
HbC:[1]					
Hand part	Slight	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: slope, shrink-swell, frost action.	Moderate: shrink-swell, low strength, frost action.
Betts part	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.	Severe: low strength.
HcA:[1]					
Hand part	Slight	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell, low strength, frost action.
Bonilla part	Severe: floods	Severe: floods, frost action.	Severe: floods	Severe: floods, frost action.	Severe: floods, frost action.
HdB:[1]					
Hand part	Slight	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: slope, shrink-swell, frost action.	Moderate: shrink-swell, low strength, frost action.
Davison part	Severe: wetness	Severe: frost action, wetness.	Severe: wetness	Severe: frost action, wetness.	Severe: frost action.
Henkin: HmA, HmB	Slight	Moderate: frost action.	Slight	Moderate: frost action.	Moderate: low strength, frost action.
Henkin variant: HnB	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: low strength.
Homme:					
HoC:[1]					
Homme part	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.

See footnote at end of table.

TABLE 5.—*Building site development*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ethan part	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: slope, shrink-swell, frost action.	Severe: low strength.
HtA:[1] Homme part	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Onita part	Severe: floods	Severe: floods, shrink-swell, frost action.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell, frost action.	Severe: floods, shrink-swell, low strength.
HtB[1]	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
James: Ja	Severe: floods, wetness, too clayey.	Severe: floods, frost action, shrink-swell.	Severe: floods, frost action, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: frost action, low strength, shrink-swell.
Lamo: La	Severe: wetness, floods.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: floods, shrink-swell, frost action.
Lm:[1] Lamo part	Severe: wetness, floods.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: floods, shrink-swell, frost action.
Wann part	Severe: wetness, floods.	Severe: floods, frost action.	Severe: floods, wetness.	Severe: floods, frost action.	Severe: floods, frost action.
Marsh: Ma. (Properties too variable to be rated.)					
Onita: OaA	Severe: floods	Severe: floods, shrink-swell, frost action.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell, frost action.	Severe: floods, shrink-swell, low strength.
Prosper: PcA:[1] Prosper part	Severe: floods, wetness.	Severe: floods, frost action.	Severe: floods, wetness.	Severe: floods, frost action.	Severe: low strength, frost action.
Clarno part	Moderate: too clayey.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.	Severe: low strength.
Pr:[1] Prosper part	Severe: floods, wetness.	Severe: floods	Severe: floods, wetness.	Severe: floods	Severe: low strength.
Stickney part	Moderate: wetness, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Ps:[1] Prosper part	Severe: floods, wetness.	Severe: floods, frost action.	Severe: floods, wetness.	Severe: floods, frost action.	Severe: low strength.
Crossplain part	Severe: wetness	Severe: wetness, frost action, floods.	Severe: wetness, floods.	Severe: wetness, frost action, floods.	Severe: frost action, shrink-swell, low strength.

See footnote at end of table.

TABLE 5.—*Building site development*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Redstoe: ReB	Moderate: depth to rock.	Moderate: frost action.	Moderate: depth to rock.	Moderate: frost action.	Moderate: low strength, frost action.
Salmo: Sa	Severe: floods, wetness.	Severe: floods, wetness, frost action.	Severe: floods, wetness.	Severe: floods, wetness, frost action.	Severe: floods, frost action, low strength.
Storla variant: St	Severe: wetness.	Severe: frost action, wetness.	Severe: wetness.	Severe: frost action, wetness.	Severe: frost action, wetness.
Tetonka: Te	Severe: wetness, floods.	Severe: floods, frost action, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, frost action, shrink-swell.	Severe: frost action, low strength, shrink-swell.
Tt:[1] Tetonka part	Severe: wetness, floods.	Severe: floods, frost action, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, frost action, shrink-swell.	Severe: frost action, low strength, shrink-swell.
Harps part	Severe: wetness	Severe: wetness, low strength, frost action.	Severe: wetness, low strength.	Severe: wetness, low strength, frost action.	Severe: wetness, low strength, frost action.
Tw:[1] Tetonka part	Severe: wetness, floods.	Severe: floods, frost action, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, frost action, shrink-swell.	Severe: frost action, low strength, shrink-swell.
Whitewood part	Severe: wetness, floods.	Severe: floods, frost action.	Severe: wetness, floods.	Severe: floods, frost action.	Severe: frost action, low strength.
Wann: Wa	Severe: wetness, floods.	Severe: floods, frost action.	Severe: floods, wetness.	Severe: floods, frost action.	Severe: floods, frost action.
Worthing: Ww	Severe: wetness, floods, too clayey.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, low strength.

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 6 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight,* soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good, fair,* or *poor,* which, respectively, mean about the same as the terms *slight, moderate,* and *severe.*

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of

TABLE 6.—*Sanitary facilities*

["Seepage" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils]

Soil series and map symbols	Degree and kind of limitation for—				Suitability for daily cover for landfill
	Septic tank absorption fields	Sewage lagoons	Trench sanitary landfill	Area sanitary landfill	
Betts: BeE[1]	Severe: slope, percs slowly.	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Bon: Bo	Severe: floods	Severe: floods, seepage.	Severe: floods	Severe: floods	Good.
Chaska: Ca,[1] Cb[1]	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Clamo: Cc	Severe: floods, percs slowly, wetness.	Severe: floods	Severe: floods, wetness.	Severe: floods, wetness.	Poor: too clayey.
Clarno:					
CdA, CsA[1]	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
CdB	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
CeA:[1]					
Clarno part	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Davison part	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Good.
CeB:[1]					
Clarno part	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Davison part	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Good.
CnC:[1]	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Crossplain:					
Ct:[1]					
Crossplain part	Severe: percs slowly, wetness, floods.	Slight	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Harps part	Severe: wetness.	Slight	Severe: wetness.	Severe: wetness.	Poor: wetness.
Davis: DaB, DaC	Moderate: percs slowly.	Moderate: slope, seepage.	Slight	Slight	Good.
Davison:					
DbA[1]	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Good.
DcB:[1]					
Davison part	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Good.
Onita part	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Delmont:					
DeA, DeB	Slight[2]	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.

See footnotes at end of table.

TABLE 6.—*Sanitary facilities*—Continued

Soil series and map symbols	Degree and kind of limitation for—				Suitability for daily cover for landfill
	Septic tank absorption fields	Sewage lagoons	Trench sanitary landfill	Area sanitary landfill	
DmB:[1] Delmont part	Slight[2]	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
Rock outcrop part. (Too variable to be rated.)					
DnD:[1] Delmont part	Slight[2]	Severe: slope, seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
Talmo part	Moderate: slope.[2]	Severe: slope, seepage.	Severe: seepage, small stones.	Severe: seepage.	Poor: thin layer.
Dimo: Do	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Fair: thin layer.
Dudley:					
DsA:[1] Dudley part	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey, hard to pack.
Stickney part	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Durrstein: Du	Severe: floods, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: too clayey, wetness.
Egan:					
EaC	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Slight	Fair: too clayey.
EbC2:[1] Egan part	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Betts part	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Slight	Fair: too clayey.
EgB:[1] Egan part	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Wentworth part	Moderate: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Enet: EnA	Slight[2]	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: thin layer, area reclaim.
Ethan:					
EtB[1]	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
EtC2,[1] EuC,[1] EwC[1]	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Slight	Fair: too clayey.
EtD:[1] Ethan part	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Moderate: slope.	Fair: slope, too clayey.
Betts part	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Moderate: slope.	Fair: too clayey.
EuB:[1] Ethan part	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Clarno part	Severe: percs slowly.	Moderate: slope.	Slight	Slight	Good.

See footnotes at end of table.

TABLE 6.—*Sanitary facilities*—Continued

Soil series and map symbols	Degree and kind of limitation for—				Suitability for daily cover for landfill
	Septic tank absorption fields	Sewage lagoons	Trench sanitary landfill	Area sanitary landfill	
Fedora: Fa [1]	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness.	Severe: wetness, seepage.	Poor: wetness.
Hand:					
HaA	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
HaB	Moderate: percs slowly.	Moderate: slope, seepage.	Slight	Slight	Good.
HaC	Moderate: percs slowly.	Severe: slope	Slight	Slight	Good.
HbC: [1]					
Hand part	Moderate: percs slowly.	Severe: slope	Slight	Slight	Good.
Betts part	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Slight	Fair: too clayey.
HcA: [1]					
Hand part	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
Bonilla part	Severe: floods, percs slowly.	Moderate: seepage.	Severe: floods	Severe: floods	Good.
HdB: [1]					
Hand part	Moderate: percs slowly.	Moderate: slope, seepage.	Slight	Slight	Good.
Davison part	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Good.
Henkin: HmA, HmB	Slight [2]	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Henkin variant: HnB	Slight [2]	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: thin layer, area reclaim.
Homme:					
HoC [1]	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Slight	Fair: too clayey.
HtA: [1]					
Homme part	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Onita part	Severe: percs slowly, floods.	Slight	Severe: floods	Severe: floods	Fair: too clayey.
HtB [1]	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
James: Ja	Severe: floods, percs slowly, wetness.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, wetness.
Lamo:					
La	Severe: percs slowly, wetness, floods.	Severe: floods	Severe: wetness, floods.	Severe: wetness, floods.	Fair: too clayey.
Lm: [1]					
Lamo part	Severe: percs slowly, wetness, floods.	Severe: floods	Severe: wetness, floods.	Severe: wetness, floods.	Fair: too clayey.
Wann part	Severe: wetness, floods.	Severe: seepage, floods.	Severe: floods, wetness.	Severe: floods, wetness.	Good.

See footnotes at end of table.

TABLE 6.—*Sanitary facilities*—Continued

Soil series and map symbols	Degree and kind of limitation for—				Suitability for daily cover for landfill
	Septic tank absorption fields	Sewage lagoons	Trench sanitary landfill	Area sanitary landfill	
Marsh: Ma. (Too variable to be rated.)					
Onita: OaA	Severe: percs slowly, floods.	Slight	Severe: floods	Severe: floods	Fair: too clayey.
Prosper:					
PcA:[1]					
Prosper part	Severe: floods, percs slowly.	Slight	Severe: floods, wetness.	Severe: floods	Fair: too clayey.
Clarno part	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Pr:[1]					
Prosper part	Severe: floods, percs slowly.	Slight	Severe: floods, wetness.	Severe: floods	Fair: too clayey.
Stickney part	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Ps:[1]					
Prosper part	Severe: floods, percs slowly.	Slight	Severe: floods, wetness.	Severe: floods	Fair: too clayey.
Crossplain part	Severe: percs slowly, wetness, floods.	Slight	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Redstoe: ReB	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight	Fair: thin layer, area reclaim.
Salmo: Sa	Severe: percs slowly, floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Storla variant: St	Severe: wetness.[2]	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: wetness.
Tetonka:					
Te	Severe: floods, percs slowly, wetness.	Slight	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Tt:[1]					
Tetonka part	Severe: floods, percs slowly, wetness.	Slight	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Harps part	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Tw:[1]					
Tetonka part	Severe: floods, percs slowly, wetness.	Slight	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Whitewood part	Severe: percs slowly, wetness, floods.	Slight	Severe: floods, wetness.	Severe: floods, wetness.	Fair: too clayey.
Wann: Wa	Severe: wetness.	Severe: seepage.	Severe: floods, wetness.	Severe: floods, wetness.	Good.
Worthing: Ww	Severe: percs slowly, floods.	Slight	Severe: wetness, floods, too clayey.	Severe: wetness, floods.	Poor: wetness, too clayey.

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

[2] Excessive permeability may cause pollution of ground water.

the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 6 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 7, soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Aquifer-fed excavated ponds are bodies of water made by excavating a pit or dugout into a groundwater aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 7 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer, quality of the water, and ease of excavation.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

TABLE 7.—*Water management*

["Seepage" and some of the other terms that describe restrictive soil features are defined in the Glossary. Absence of an entry means soil was not evaluated]

Soil series and map symbols	Soil and site features affecting—					
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
Betts:						
BeE:[1]						
Betts part	Slope	Low strength, shrink-swell.	No water	Not needed	Slope	Slope, erodes easily.
Ethan part	Slope	Low strength, compressible, shrink-swell.	No water	Not needed	Slope	Slope, erodes easily.
Bon: Bo	Seepage	Low strength, piping.	Deep to water	Floods	Not needed	Not needed.
Chaska: Ca,[1] Cb[1]	Seepage	Compressible, low strength, piping.	Favorable	Wetness, floods.	Not needed	Wetness.
Clamo: Cc	Favorable	Low strength, shrink-swell.	Slow refill	Percs slowly, wetness, frost action.	Not needed	Not needed.
Clarno:						
CdA	Favorable	Low strength	No water	Not needed	Not needed	Favorable.
CdB	Slope	Low strength	No water	Not needed	Complex slope	Slope, erodes easily.
CeA:[1]						
Clarno part	Favorable	Low strength	No water	Not needed	Not needed	Favorable.
Davison part	Seepage	Low strength, piping.	Deep to water	Complex slope, poor outlets.	Not needed	Favorable.
CeB:[1]						
Clarno part	Favorable	Low strength	No water	Not needed	Complex slope	Slope, erodes easily.
Davison part	Seepage	Low strength, piping.	Deep to water	Complex slope, poor outlets.	Complex slope	Slope, erodes easily.
CnC:[1]						
Clarno part	Slope	Low strength	No water	Not needed	Complex slope	Slope, erodes easily.
Ethan part	Slope	Low strength, compressible, shrink-swell.	No water	Not needed	Complex slope	Slope, erodes easily.
CsA:[1]						
Clarno part	Favorable	Low strength	No water	Not needed	Not needed	Favorable.
Stickney part	Favorable	Low strength, compressible, hard to pack.	No water	Percs slowly, poor outlets.	Not needed	Favorable.
Crossplain:						
Ct:[1]						
Crossplain part	Favorable	Low strength, shrink-swell.	Deep to water	Poor outlets, percs slowly, wetness.	Not needed	Favorable.
Harps part	Favorable	Low strength, compressible.	Deep to water	Frost action, poor outlets.	Not needed	Not needed.
Davis: DaB, DaC	Seepage	Low strength	No water	Not needed	Favorable	Slope, erodes easily.
Davison:						
DbA[1]	Seepage	Low strength, piping.	Deep to water	Complex slope, poor outlets.	Not needed	Favorable.

See footnote at end of table.

TABLE 7.—*Water management*—Continued

Soil series and map symbols	Soil and site features affecting—					
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
DcB:[1]						
Davison part	Seepage	Low strength, piping.	Deep to water	Complex slope, poor outlets.	Complex slope	Favorable.
Onita part	Slope	Low strength, shrink-swell, compressible.	Deep to water	Not needed	Complex slope, percs slowly.	Slope, erodes easily.
Delmont:						
DeA, DeB, DmB[1] (Rock outcrop part of DmB is too variable to be evaluated.)	Seepage	Seepage, piping.	No water	Not needed	Complex slope, too sandy, rooting depth.	Droughty, erodes easily, rooting depth.
DnD:[1]						
Delmont part	Seepage	Seepage, piping.	No water	Not needed	Complex slope, too sandy, rooting depth.	Droughty, erodes easily, rooting depth.
Talmo part	Seepage, slope.	Seepage	No water	Not needed	Not needed	Droughty, slope, erodes easily.
Dimo: Do	Seepage	Low strength	Deep to water	Poor outlets, wetness.	Not needed	Favorable.
Dudley:						
DsA:[1]						
Dudley part	Favorable	Low strength, compressible, shrink-swell.	No water	Percs slowly, poor outlets.	Not needed	Excess alkali, droughty.
Stickney part	Favorable	Low strength, compressible, hard to pack.	No water	Percs slowly, poor outlets.	Not needed	Favorable.
Durrstein: Du	Favorable	Low strength, compressible, hard to pack.	Deep to water	Floods, frost action, excess salt.	Not needed	Excess alkali, excess salt, wetness.
Egan:						
EaC	Slope	Shrink-swell, low strength, piping.	No water	Not needed	Favorable	Slope, erodes easily.
EbC2:[1]						
Egan part	Slope	Shrink-swell, low strength, piping.	No water	Not needed	Favorable	Slope, erodes easily.
Betts part	Slope	Low strength, shrink-swell.	No water	Not needed	Complex slope	Slope, erodes easily.
EgB:[1]						
Egan part	Slope	Shrink-swell, low strength, piping.	No water	Not needed	Favorable	Slope, erodes easily.
Wentworth part	Slope, seepage.	Low strength, piping, shrink-swell.	No water	Not needed	Favorable	Slope, erodes easily.
Enet: EnA	Seepage	Low strength	No water	Not needed	Not needed	Droughty.

See footnote at end of table.

TABLE 7.—*Water management*—Continued

Soil series and map symbols	Soil and site features affecting—					
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
Ethan:						
EtB,[1] EtC2:[1]						
Ethan part	Slope	Low strength, compressible, shrink-swell.	No water	Not needed	Complex slope	Slope, erodes easily.
Betts part	Slope	Low strength, shrink-swell.	No water	Not needed	Complex slope	Slope, erodes easily.
EtD:[1]						
Ethan part	Slope	Low strength, compressible, shrink-swell.	No water	Not needed	Slope	Slope, erodes easily.
Betts part	Slope	Low strength, shrink-swell.	No water	Not needed	Slope	Slope, erodes easily.
EuB,[1] EuC:[1]						
Ethan part	Slope	Low strength, compressible, shrink-swell.	No water	Not needed	Complex slope	Slope, erodes easily.
Clarno part	Slope	Low strength	No water	Not needed	Complex slope	Slope, erodes easily.
EwC:[1]						
Ethan part	Slope	Low strength, compressible, shrink-swell.	No water	Not needed	Complex slope	Slope, erodes easily.
Homme part	Slope	Low strength, compressible, hard to pack.	No water	Not needed	Favorable	Slope, erodes easily.
Fedora: Fa[1]	Seepage	Piping, seepage.	Favorable	Cutbanks cave, poor outlets, frost action.	Not needed	Favorable.
Hand:						
HaA	Seepage	Low strength	No water	Not needed	Not needed	Favorable.
HaB, HaC	Slope, seepage.	Low strength	No water	Not needed	Complex slope	Slope, erodes easily.
HbC:[1]						
Hand part	Slope, seepage.	Low strength	No water	Not needed	Complex slope	Slope, erodes easily.
Betts part	Slope	Low strength, shrink-swell.	No water	Not needed	Complex slope	Slope, erodes easily.
HcA:[1]						
Hand part	Seepage	Low strength	No water	Not needed	Not needed	Favorable.
Bonilla part	Seepage	Low strength, piping.	Deep to water	Poor outlets	Not needed	Favorable.
HdB:[1]						
Hand part	Slope, seepage.	Low strength	No water	Not needed	Complex slope	Slope, erodes easily.
Davison part	Seepage	Low strength, piping.	Deep to water	Complex slope, poor outlets.	Complex slope	Favorable.
Henkin:						
HmA	Seepage	Low strength, piping.	No water	Not needed	Not needed	Erodes easily.
HmB	Seepage	Low strength, piping.	No water	Not needed	Complex slope	Slope, erodes easily.

See footnote at end of table.

TABLE 7.—*Water management*—Continued

Soil series and map symbols	Soil and site features affecting—					
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
Henkin variant: HnB	Seepage	Piping	No water	Not needed	Complex slope	Slope, erodes easily.
Homme:						
HoC:[1]						
Homme part	Slope	Low strength, compressible, hard to pack.	No water	Not needed	Favorable	Slope, erodes easily.
Ethan part	Slope	Low strength, compressible, shrink-swell.	No water	Not needed	Complex slope	Slope, erodes easily.
HtA:[1]						
Homme part	Favorable	Low strength, compressible, hard to pack.	No water	Not needed	Not needed	Favorable.
Onita part	Favorable	Low strength, shrink-swell, compressible.	Deep to water	Poor outlets, percs slowly.	Not needed	Favorable.
HtB:[1]						
Homme part	Slope	Low strength, compressible, hard to pack.	No water	Not needed	Favorable	Slope, erodes easily.
Onita part	Slope	Low strength, shrink-swell, compressible.	Deep to water	Not needed	Complex slope, percs slowly.	Slope, erodes easily.
James: Ja	Favorable	Low strength, shrink-swell, compressible.	Slow refill	Percs slowly, wetness, frost action.	Not needed	Excess salt, wetness.
Lamo:						
La	Favorable	Compressible, erodes easily, shrink-swell.	Deep to water	Floods, percs slowly.	Wetness	Not needed.
Lm:[1]						
Lamo part	Favorable	Compressible, erodes easily, shrink-swell.	Deep to water	Floods, percs slowly.	Wetness	Not needed.
Wann part	Seepage	Piping	Favorable	Wetness, floods.	Not needed	Not needed.
Marsh: Ma. (Properties too variable to be evaluated.)						
Onita: OaA	Favorable	Low strength, shrink-swell, compressible.	Deep to water	Poor outlets, percs slowly.	Not needed	Favorable.
Prosper:						
PcA:[1]						
Prosper part	Favorable	Low strength	Deep to water	Poor outlets, percs slowly.	Not needed	Favorable.
Clarno part	Favorable	Low strength	No water	Not needed	Not needed	Favorable.
Pr:[1]						
Prosper part	Favorable	Low strength	Deep to water	Poor outlets, percs slowly.	Not needed	Favorable.
Stickney part	Favorable	Low strength, compressible, hard to pack.	No water	Percs slowly, poor outlets.	Not needed	Favorable.

See footnote at end of table.

TABLE 7.—*Water management*—Continued

Soil series and map symbols	Soil and site features affecting—					
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
Ps:[1]						
Prosper part	Favorable	Low strength	Deep to water	Poor outlets, percs slowly.	Not needed	Favorable.
Crossplain part	Favorable	Low strength, shrink-swell.	Deep to water	Poor outlets, percs slowly, wetness.	Not needed	Favorable.
Redstoe: ReB	Slope, depth to rock.	Low strength, piping, hard to pack.	No water	Not needed	Depth to rock, piping, erodes easily.	Slope, erodes easily.
Salmo: Sa	Favorable	Low strength	Slow refill	Floods, wetness, excess salt.	Not needed	Excess salt, wetness.
Storla variant: St	Seepage	Piping, low strength.	Favorable	Poor outlets, wetness, frost action.	Not needed	Favorable.
Tetonka: Te	Favorable	Low strength, compressible, shrink-swell.	Slow refill	Poor outlets, percs slowly, floods.	Not needed	Wetness.
Tf:[1]						
Tetonka part	Favorable	Low strength, compressible, shrink-swell.	Slow refill	Poor outlets, percs slowly, floods.	Not needed	Wetness.
Harps part	Favorable	Low strength, compressible.	Deep to water	Frost action, poor outlets.	Not needed	Not needed.
Tw:[1]						
Tetonka part	Favorable	Low strength, compressible, shrink-swell.	Slow refill	Poor outlets, percs slowly, floods.	Not needed	Wetness.
Whitewood part	Favorable	Low strength, compressible, hard to pack.	Slow refill	Poor outlets, floods, percs slowly.	Not needed	Favorable.
Wann: Wa	Seepage	Piping	Favorable	Wetness, floods.	Not needed	Not needed.
Worthing: Ww	Favorable	Low strength, compressible, shrink-swell.	Slow refill	Poor outlets, frost action, percs slowly.	Not needed	Not needed.

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 8 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the section "Description of the Soils."

TABLE 8.—*Construction materials*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor"]

Soil series and map symbols	Suitability as a source of—			
	Roadfill	Sand	Gravel	Topsoil
Betts: BeE[1]	Poor: low strength.	Unsuited	Unsuited	Poor: thin layer, slope.
Bon: Bo	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
Chaska: Ca,[1] Cb[1]	Poor: wetness, frost action.	Unsuited	Unsuited	Poor: wetness.
Clamo: Cc[1]	Poor: frost action, shrink-swell, low strength.	Unsuited	Unsuited	Poor: wetness, too clayey.
Clarno:				
CdA, CdB	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
CeA,[1] CeB:[1]				
Clarno part	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Davison part	Poor: frost action	Unsuited	Unsuited	Fair: excess lime.
CnC:[1]				
Clarno part	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Ethan part	Poor: low strength.	Unsuited	Unsuited	Poor: thin layer.
CsA:[1]				
Clarno part	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Stickney part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer, excess salt.
Crossplain:				
Ct:[1]				
Crossplain part	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor: wetness.
Harps part	Poor: low strength, frost action, wetness.	Unsuited	Unsuited	Poor: wetness.
Davis: DaB, DaC	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Good.
Davison:				
DbA[1]	Poor: frost action	Unsuited	Unsuited	Fair: excess lime.
DcB:[1]				
Davison part	Poor: frost action	Unsuited	Unsuited	Fair: excess lime.
Onita part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer.
Delmont:				
DeA, DeB, DmB.[1] (Rock outcrop part of DmB is too variable to be rated.)	Good	Fair: excess fines	Fair: excess fines	Fair: thin layer, area reclaim.

See footnote at end of table.

TABLE 8.—*Construction materials*—Continued

Soil series and map symbols	Suitability as a source of—			
	Roadfill	Sand	Gravel	Topsoil
DnD:[1]				
Delmont part	Good	Fair: excess fines	Fair: excess fines	Fair: thin layer, area reclaim.
Talmo part	Good	Fair: excess fines	Good	Poor: thin layer, area reclaim.
Dimo: Do	Fair: wetness	Fair: excess fines	Poor: excess fines	Fair: thin layer, too clayey.
Dudley:				
DsA:[1]				
Dudley part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: area reclaim, excess salt, thin layer.
Stickney part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: too clayey, excess salt.
Durrstein: Du	Poor: low strength, shrink-swell, area reclaim.	Unsuited	Unsuited	Poor: thin layer, area reclaim, excess salt.
Egan:				
EaC	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: thin layer.
EbC2:[1]				
Egan part	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: thin layer.
Betts part	Poor: low strength.	Unsuited	Unsuited	Poor: thin layer.
EgB:[1]				
Egan part	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: thin layer.
Wentworth part	Poor: low strength.	Unsuited	Unsuited	Fair: too clayey.
Enet: EnA	Fair: low strength.	Fair: excess fines	Good	Fair: area reclaim.
Ethan:				
EtB,[1] EtC2,[1] EtD[1]	Poor: low strength.	Unsuited	Unsuited	Poor: thin layer.
EuB,[1] EuC:[1]				
Ethan part	Poor: low strength.	Unsuited	Unsuited	Poor: thin layer.
Clarno part	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
EwC:[1]				
Ethan part	Poor: low strength.	Unsuited	Unsuited	Poor: thin layer.
Homme part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey, thin layer.
Fedora: Fa[1]	Poor: wetness	Fair: excess fines	Poor: excess fines	Poor: wetness, excess lime.
Hand:				
HaA, HaB, HaC	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.

See footnote at end of table.

TABLE 8.—*Construction materials*—Continued

Soil series and map symbols	Suitability as a source of—			
	Roadfill	Sand	Gravel	Topsoil
HbC:[1]				
Hand part	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.
Betts part	Poor: low strength.	Unsuited	Unsuited	Poor: thin layer.
HcA:[1]				
Hand part	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.
Bonilla part	Poor: low strength.	Unsuited	Unsuited	Good.
HdB:[1]				
Hand part	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.
Davison part	Poor: frost action	Unsuited	Unsuited	Fair: excess lime.
Henkin: HmA, HmB	Fair: low strength, frost action.	Poor: excess fines	Unsuited	Good.
Henkin variant: HnB	Fair: low strength.	Fair: excess fines	Good	Fair: area reclaim.
Homme:				
HoC:[1]				
Homme part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey, thin layer.
Ethan part	Poor: low strength.	Unsuited	Unsuited	Poor: thin layer.
HtA,[1] HtB:[1]				
Homme part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey, thin layer.
Onita part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer.
James: Ja	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: too clayey, excess salt, wetness.
Lamo:				
La	Poor: shrink-swell, frost action, low strength.	Unsuited	Unsuited	Fair: too clayey.
Lm:[1]				
Lamo part	Poor: shrink-swell, frost action, low strength.	Unsuited	Unsuited	Fair: too clayey.
Wann part	Poor: frost action	Poor: excess fines	Unsuited	Good.
Marsh: Ma. (Too variable to be rated.)				
Onita: OaA	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer.
Prosper:				
PcA[1]	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Pr:[1]				
Prosper part	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.

See footnote at end of table.

TABLE 8.—*Construction materials*—Continued

Soil series and map symbols	Suitability as a source of—			
	Roadfill	Sand	Gravel	Topsoil
Stickney part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: too clayey, excess salt.
Ps:[1] Prosper part	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Crossplain part	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor: wetness.
Redstoe: ReB	Fair: low strength, thin layer.	Unsuited	Unsuited	Poor: thin layer, excess lime.
Salmo: Sa	Severe: low strength, wetness, frost action.	Unsuited	Unsuited	Poor: wetness, excess salt.
Storla variant: St	Poor: wetness, frost action.	Poor: excess fines	Poor: excess fines	Poor: wetness.
Tetonka: Te	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: wetness.
Tt:[1] Tetonka part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: wetness.
Harps part	Poor: low strength, frost action, wetness.	Unsuited	Unsuited	Poor: wetness.
Tw:[1] Tetonka part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: wetness.
Whitewood part	Poor: low strength.	Unsuited	Unsuited	Fair: too clayey, wetness.
Wann: Wa	Poor: frost action.	Poor: excess fines	Unsuited	Good.
Worthing: Ww	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: wetness, too clayey.

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 9 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 8 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected

mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Soil Properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering Properties

Table 9 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 9 gives information for each of these contrasting horizons in a typical profile. Depth to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Description of the Soils."

Texture is described in table 9 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL–ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A–1 are coarse grained and low in content of fines. At the other extreme, in group A–7, are fine-grained soils. Highly organic soils are classified in group A–8 on the basis of visual inspection.

When laboratory data are available, the A–1, A–2, and A–7 groups are further classified as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As an additional refinement, the desirabil-

TABLE 9.—*Engineering properties and classifications*

[The symbol < means less than; > means greater than]

Soil series and map symbols	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4 (4.7 mm)	10 (2.0 mm)	40 (0.42 mm)	200 (0.074 mm)		
	In				*Pct*					*Pct*	
Betts:											
BeE:[1]											
Betts part	0–5	Loam	CL, CL–ML	A–4, A–6	0–5	90–100	80–100	75–100	60–75	20–38	5–19
	5–32	Loam, clay loam.	CL	A–6, A–7	0–5	90–100	85–100	75–100	50–85	25–45	11–30
	32–50	Clay loam	CL	A–6, A–7	0–5	90–100	85–100	75–100	50–85	25–45	11–25
Ethan part	0–9	Loam	CL, ML	A–4, A–6	0	95–100	90–100	80–95	55–80	30–40	5–25
	9–28	Loam, clay loam.	CL	A–6, A–7	0–5	95–100	95–100	85–100	55–80	30–45	10–25
	28–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0–5	90–100	85–100	75–100	50–95	25–50	5–25
Bon: Bo	0–32	Loam	CL–ML, CL	A–4, A–6	0	100	95–100	75–95	60–85	20–38	5–20
	32–60	Stratified loam to loamy fine sand.	CL–ML, SM, SC	A–2, A–4	0	90–100	85–100	50–90	30–75	<20	NP[2]–10
Chaska: Ca,[1] Cb.[1]	0–8	Loam	CL, CL–ML	A–4	0	100	100	90–100	70–80	30–40	5–10
	8–28	Stratified silt loam to loamy fine sand.	CL, CL–ML	A–4	0	100	100	85–95	60–75	20–40	5–10
	28–60	Stratified fine sandy loam to fine sand.	SM	A–4, A–2	0	100	100	85–95	25–45	<20	NP–10
Clamo: Cc	0–5	Silty clay loam.	CL, CH	A–6, A–7	0	100	95–100	90–100	85–100	40–60	17–33
	5–60	Silty clay loam, silty clay.	CL, CH, MH	A–7	0	100	95–100	90–100	85–100	45–75	20–45
Clarno:											
CdA, CdB	0–9	Loam	ML, CL	A–4, A–6	0	100	95–100	85–100	55–90	30–40	5–20
	9–36	Loam, clay loam.	CL	A–4, A–6, A–7	0	95–100	90–100	80–100	55–85	30–45	5–25
	36–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0	90–100	90–100	80–100	50–80	25–45	5–20
CeA,[1] CeB:[1]											
Clarno part	0–9	Loam	ML, CL	A–4, A–6	0	100	95–100	85–100	55–90	30–40	5–20
	9–36	Loam, clay loam.	CL	A–4, A–6, A–7	0	95–100	90–100	80–100	55–85	30–45	5–25
	36–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0	90–100	90–100	80–100	50–80	25–45	5–20
Davison part.	0–9	Loam	CL–ML, CL	A–4, A–6	0	95–100	95–100	85–95	60–75	25–40	5–20
	9–25	Loam, clay loam.	ML, CL	A–4, A–6	0	95–100	95–100	85–100	60–80	25–35	5–15
	25–60	Stratified clay loam to sandy loam.	ML, CL, SM–SC, SC	A–4, A–6	0–5	90–100	80–100	65–95	40–75	20–35	5–15

See footnotes at end of table.

TABLE 9.—*Engineering properties and classifications*—Continued

Soil series and map symbols	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4 (4.7 mm)	10 (2.0 mm)	40 (0.42 mm)	200 (0.074 mm)		
	In				*Pct*					*Pct*	
CnC:[1]											
Clarno part.	0–9	Loam	ML, CL	A–4, A–6	0	100	95–100	85–100	55–90	30–40	5–20
	9–36	Loam, clay loam.	CL	A–4, A–6, A–7	0	95–100	90–100	80–100	55–85	30–45	5–25
	36–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0	90–100	90–100	80–100	50–80	25–45	5–20
Ethan part	0–9	Loam	CL, ML	A–4, A–6	0	95–100	90–100	80–95	55–80	30–40	5–25
	9–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0–5	90–100	85–100	75–100	50–95	25–50	5–25
CsA:[1]											
Clarno part	0–9	Loam	ML, CL	A–4, A–6	0	100	95–100	85–100	55–90	30–40	5–20
	9–36	Loam, clay loam.	CL	A–4, A–6, A–7	0	95–100	90–100	80–100	55–85	30–45	5–25
	36–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0	90–100	90–100	80–100	50–80	25–45	5–20
Stickney part.	0–15	Loam	CL, ML	A–4, A–6	0	100	95–100	85–95	60–90	30–40	8–20
	15–40	Clay loam, silty clay loam, clay.	CL, CH	A–4, A–6	0	100	95–100	85–100	65–95	35–60	14–35
	40–60	Clay loam, loam.	CL, CH	A–6, A–7	0–5	95–100	90–100	80–100	55–90	35–55	10–30
Crossplain:											
Ct:[1]											
Crossplain part.	0–9	Clay loam	CL	A–4, A–6	0	100	100	90–100	70–80	30–40	9–20
	9–28	Clay loam, clay.	CL, CH	A–7	0	100	95–100	90–100	70–85	40–55	16–30
	28–60	Clay loam, loam.	CL	A–6, A–7	0	95–100	95–100	85–100	60–80	30–45	10–25
Harps part	0–10	Loam	CL, CH	A–6, A–7	0–5	100	95–100	80–90	65–80	30–45	10–20
	10–60	Loam, clay loam, sandy clay loam.	CL	A–6, A–7	0–5	95–100	95–100	80–90	65–80	30–45	10–20
Davis: DaB, DaC.	0–27	Loam	CL, ML	A–4, A–6	0	100	90–100	80–100	50–95	25–40	5–25
	27–52	Loam	CL, ML	A–4, A–6	0	100	95–100	85–100	55–90	25–40	5–20
	52–60	Stratified loam to loamy sand.	SM, SC, ML	A–2, A–4	0–5	95–100	90–100	80–95	30–70	20–35	NP–10
Davison:											
DbA[1]	0–9	Loam	CL–ML, CL	A–4, A–6	0	95–100	95–100	85–95	60–75	25–40	5–20
	9–25	Loam, clay loam.	ML, CL	A–4, A–6	0	95–100	95–100	85–100	60–80	25–35	5–15
	25–60	Stratified clay loam to sandy loam.	ML, CL, SM–SC, SC	A–4, A–6	0–5	90–100	80–100	65–95	40–75	20–35	5–15
DcB:[1]											
Davison part.	0–9	Loam	CL–ML, CL	A–4, A–6	0	95–100	95–100	85–95	60–75	25–40	5–20
	9–25	Loam, clay loam.	ML, CL	A–4, A–6	0	95–100	95–100	85–100	60–80	25–35	5–15
	25–60	Stratified clay loam to sandy loam.	ML, CL, SM–SC, SC	A–4, A–6	0–5	90–100	80–100	65–95	40–75	20–35	5–15

See footnotes at end of table.

TABLE 9.—*Engineering properties and classifications*—Continued

Soil series and map symbols	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4 (4.7 mm)	10 (2.0 mm)	40 (0.42 mm)	200 (0.074 mm)		
	In				*Pct*					*Pct*	
Onita part	0–9	Silt loam	ML, CL	A–4, A–6	0	100	95–100	90–100	70–100	30–40	10–20
	9–32	Silty clay loam, clay loam, silty clay.	CL, CH	A–6, A–7	0	100	95–100	90–100	75–100	35–60	10–35
	32–60	Silty clay loam, clay loam, silt loam.	CL, CH	A–6, A–7	0–5	95–100	95–100	85–100	65–100	30–55	10–30
Delmont:											
DeA, DeB, DmB.[1] (Rock outcrop part of DmB is too variable to be estimated.)	0–16	Loam	ML, CL	A–4, A–6	0	90–100	90–100	80–95	60–75	30–40	10–20
	16–60	Sand and gravel.	SW–SM, SM	A–1, A–2	0–5	60–100	40–70	15–50	5–30	<25	NP–5
DnD:[1]											
Delmont part.	0–16	Loam	ML, CL	A–4, A–6	0	90–100	90–100	80–95	60–75	30–40	10–20
	16–60	Sand and gravel.	SW–SM, SM	A–1, A–2	0–5	60–100	40–70	15–50	5–30	<25	NP–5
Talmo part	0–8	Gravelly loam.	ML, CL	A–4, A–6	0–5	80–100	70–100	55–95	40–75	20–35	5–15
	8–60	Sand and gravel.	GW, GM, SW, SM	A–1, A–2	0–5	40–80	30–50	15–35	0–15	<20	NP–5
Dimo: Do	0–9	Loam	CL	A–6	0	100	100	85–95	60–75	30–40	10–20
	9–26	Clay loam, loam, sandy clay loam.	CL	A–6	0	90–100	85–100	85–95	50–80	30–40	10–20
	26–60	Sand and gravel.	SM, SM–SC, SP–SM, SW–SM	A–1, A–2	0–5	60–90	40–70	20–60	5–30	<25	NP–5
Dudley:											
DsA:[1]											
Dudley part	0–10	Silt loam	CL–ML, CL	A–4, A–6	0	95–100	95–100	90–100	65–90	25–40	5–20
	10–24	Clay loam, silty clay loam, clay.	CL, CH	A–6, A–7	0	95–100	95–100	85–100	65–95	35–60	15–35
	24–60	Loam, clay loam.	CL	A–6, A–7	0–5	95–100	90–100	80–100	55–85	30–45	10–25
Stickney part.	0–15	Silty clay loam.	CL	A–6, A–7	0	100	100	95–100	85–95	40–47	15–25
	15–40	Clay loam, silty clay loam, clay.	CL, CH	A–6, A–7	0	100	95–100	85–100	65–95	35–60	14–35
	40–60	Clay loam, loam.	CL, CH	A–6, A–7	0–5	95–100	90–100	80–100	55–90	35–55	10–30
Durrstein: Du	0–1	Silt loam	ML, CL	A–4, A–6	0	100	100	85–100	60–90	20–35	5–15
	1–18	Silty clay, clay.	CH	A–7	0	100	100	90–100	75–95	50–85	20–50
	18–60	Silty clay, clay loam.	CH, CL	A–7	0	100	100	95–100	90–95	40–75	15–35
Egan:											
EaC	0–8	Silt loam	CL, ML	A–6, A–7	0	100	100	95–100	85–100	35–50	10–25
	8–33	Silty clay loam.	CL, CH	A–6, A–7	0	100	100	90–100	80–100	35–55	15–35
	33–60	Clay loam, loam.	CL, CH	A–6, A–7	0	95–100	80–100	70–100	60–85	30–55	10–35

See footnotes at end of table.

TABLE 9.—*Engineering properties and classifications*—Continued

Soil series and map symbols	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4 (4.7 mm)	10 (2.0 mm)	40 (0.42 mm)	200 (0.074 mm)		
	In				*Pct*					*Pct*	
EbC2:[1]											
Egan part	0–8	Silt loam	CL, ML	A–6, A–7	0	100	100	95–100	85–100	35–50	10–25
	8–33	Silty clay loam.	CL, CH	A–6, A–7	0	100	100	90–100	80–100	35–55	15–35
	33–60	Clay loam, loam.	CL, CH	A–6, A–7	0	95–100	80–100	70–100	60–85	30–55	10–35
Betts part	0–5	Loam	CL, CL–ML	A–4, A–6	0–5	90–100	80–100	75–100	60–75	20–38	5–19
	5–60	Loam, clay loam.	CL	A–6, A–7	0–5	90–100	85–100	75–100	50–85	25–45	11–30
EgB:[1]											
Egan part	0–8	Silt loam	CL, ML	A–6, A–7	0	100	100	95–100	85–100	35–50	10–25
	8–33	Silty clay loam.	CL, CH	A–6, A–7	0	100	100	90–100	80–100	35–55	15–35
	33–60	Clay loam, loam.	CL, CH	A–6, A–7	0	95–100	80–100	70–100	60–85	30–55	10–35
Wentworth part.	0–10	Silty clay loam.	CL, ML	A–6, A–7	0	100	100	95–100	80–100	35–50	10–30
	10–26	Silty clay loam, silt loam.	CL, CH, ML	A–6, A–7	0	100	100	85–100	80–100	35–55	10–30
	26–60	Stratified silty clay loam to sandy loam.	CL	A–4, A–6, A–7	0	100	95–100	85–100	60–100	30–50	5–30
Enet: EnA	0–24	Loam	ML, CL	A–4, A–6	0	90–100	85–100	70–95	40–80	25–40	5–20
	24–28	Loam, fine sandy loam, sandy loam.	CL–ML, CL, SM–SC, SC	A–4, A–6	0	90–100	85–95	60–95	45–75	20–40	5–15
	28–60	Sand and gravel.	SM, SP–SM, GW, GW–GM	A–1, A–2	0	60–85	45–70	10–60	0–35	<20	NP–5
Ethan:											
EtB,[1] EtC2,[1] EtD:[1]											
Ethan part	0–9	Loam	CL, ML	A–4, A–6	0	95–100	90–100	80–95	55–80	30–40	5–25
	9–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0–5	90–100	85–100	75–100	50–95	25–50	5–25
Betts part	0–5	Loam	CL, CL–ML	A–4, A–6	0–5	90–100	80–100	75–100	60–75	20–38	5–19
	5–60	Loam, clay loam.	CL	A–6, A–7	0–5	90–100	85–100	75–100	50–85	25–45	11–30
EuB,[1] EuC:[1]											
Ethan part	0–9	Loam	CL, ML	A–4, A–6	0	95–100	90–100	80–95	55–80	30–40	5–25
	9–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0–5	90–100	85–100	75–100	50–95	25–50	5–25
Clarno part	0–9	Loam	ML, CL	A–4, A–6	0	100	95–100	85–100	55–90	30–40	5–20
	9–36	Loam, clay loam.	CL	A–4, A–6, A–7	0	95–100	90–100	80–100	55–85	30–45	5–25
	36–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0	90–100	90–100	80–100	50–80	25–45	5–20
EwC:[1]											
Ethan part	0–9	Loam	CL, ML	A–4, A–6	0	95–100	90–100	80–95	55–80	30–40	5–25
	9–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0–5	90–100	85–100	75–100	50–95	25–50	5–25

See footnotes at end of table.

TABLE 9.—*Engineering properties and classifications*—Continued

Soil series and map symbols	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4 (4.7 mm)	10 (2.0 mm)	40 (0.42 mm)	200 (0.074 mm)		
	In				*Pct*					*Pct*	
Homme part.	0–9	Silty clay loam.	CL	A–6, A–7	0	100	95–100	95–100	85–95	35–45	15–25
	9–24	Silty clay loam.	CL, CH	A–7	0	100	95–100	95–100	85–95	40–55	15–30
	24–36	Silty clay loam, silt loam.	CL, CH	A–6, A–7	0–5	95–100	95–100	90–100	80–90	35–55	15–30
	36–60	Clay loam, loam.	CL	A–4, A–6	0–5	95–100	90–100	85–100	60–80	30–40	10–20
Fedora: Fa [1]	0–13	Fine sandy loam.	SC, SM	A–4	0	95–100	95–100	60–90	35–50	20–30	5–10
	13–33	Sandy loam, fine sandy loam, loamy sand.	SC, SM	A–4, A–2	0	95–100	70–100	50–90	15–45	15–30	NP–10
	33–60	Sandy loam, loam, silt loam.	SM, SC, ML, CL	A–4, A–6	0	95–100	95–100	60–95	35–75	20–35	5–15
Hand:											
HaA, HaB, HaC	0–17	Loam	CL, ML	A–4, A–6	0–5	95–100	85–100	75–100	50–85	25–40	5–20
	17–31	Loam, clay loam.	CL, ML	A–4, A–6	0–5	95–100	85–100	75–100	50–85	25–40	5–20
	31–60	Stratified silt loam to fine sandy loam.	ML, CL, SM, SC	A–4, A–6	0–5	95–100	80–100	70–100	35–80	20–40	5–20
HbC: [1]											
Hand part	0–17	Loam	CL, ML	A–4, A–6	0–5	95–100	85–100	75–100	50–85	25–40	5–20
	17–31	Loam, clay loam.	CL, ML	A–4, A–6	0–5	95–100	85–100	75–100	50–85	25–40	5–20
	31–60	Stratified silt loam to fine sandy loam.	ML, CL, SM, SC	A–4, A–6	0–5	95–100	80–100	70–100	35–80	20–40	5–20
Betts part	0–5	Loam	CL, CL–ML	A–4, A–6	0–5	90–100	80–100	75–100	60–75	20–38	5–19
	5–60	Loam, clay loam.	CL	A–6, A–7	0–5	90–100	85–100	75–100	50–85	25–45	11–30
HcA: [1]											
Hand part	0–17	Loam	CL, ML	A–4, A–6	0–5	95–100	85–100	75–100	50–85	25–40	5–20
	17–31	Loam, clay loam.	CL, ML	A–4, A–6	0–5	95–100	85–100	75–100	50–85	25–40	5–20
	31–60	Stratified silt loam to fine sandy loam.	ML, CL, SM, SC	A–4, A–6	0–5	95–100	80–100	70–100	35–80	20–40	5–20
Bonilla part	0–9	Loam	CL–ML, CL	A–4, A–6	0	100	95–100	75–100	50–90	25–35	5–15
	9–24	Loam, clay loam.	CL	A–4, A–6	0	100	95–100	85–100	60–90	30–40	10–20
	24–37	Loam, clay loam.	CL	A–4, A–6	0–5	95–100	95–100	85–100	60–90	30–40	10–20
	37–60	Stratified clay loam to fine sandy loam.	CL–ML, CL, SM–SC, SC	A–4, A–6	0–5	95–100	85–100	70–95	40–90	20–35	5–15
HdB: [1]											
Hand part	0–17	Loam	CL, ML	A–4, A–6	0–5	95–100	85–100	75–100	50–85	25–40	5–20
	17–31	Loam, clay loam.	CL, ML	A–4, A–6	0–5	95–100	85–100	75–100	50–85	25–40	5–20
	31–60	Stratified silt loam to fine sandy loam.	ML, CL, SM, SC	A–4, A–6	0–5	95–100	80–100	70–100	35–80	20–40	5–20

See footnotes at end of table.

TABLE 9.—*Engineering properties and classifications*—Continued

Soil series and map symbols	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4 (4.7 mm)	10 (2.0 mm)	40 (0.42 mm)	200 (0.074 mm)		
	In				*Pct*					*Pct*	
Davison part.	0–9	Loam	CL–ML, CL	A–4, A–6	0	95–100	95–100	85–95	60–75	25–40	5–20
	9–25	Loam, clay loam.	ML, CL	A–4, A–6	0	95–100	95–100	85–100	60–80	25–35	5–15
	25–60	Stratified clay loam to sandy loam.	ML, CL, SM–SC, SC	A–4, A–6	0–5	90–100	80–100	65–95	40–75	20–35	5–15
Henkin: HmA, HmB.	0–19	Fine sandy loam.	SM, SC	A–2, A–4	0–5	90–100	80–100	65–85	30–45	15–30	NP–10
	19–34	Loam, sandy loam, fine sandy loam.	SM, SC, ML, CL	A–2, A–4	0–5	90–100	80–100	60–85	30–55	15–30	NP–10
	34–60	Stratified fine sand to loam.	SM, SC, ML, SW–SM	A–2, A–4	0–5	90–100	80–100	35–85	5–65	15–30	NP–10
Henkin variant: HnB.	0–23	Fine sandy loam.	SM, SC	A–2, A–4	0	90–100	80–100	65–85	30–45	17–30	NP–10
	23–60	Sand and gravel.	SM, SP–SM, GW, GW–GM	A–1, A–2	0	60–85	45–70	10–60	0–35	<20	NP–5
Homme: HoC:[1] Homme part.	0–9	Silty clay loam.	CL	A–6, A–7	0	100	95–100	95–100	85–95	35–45	15–25
	9–24	Silty clay loam.	CL, CH	A–7	0	100	95–100	95–100	85–95	40–55	15–30
	24–36	Silty clay loam, silt loam.	CL, CH	A–6, A–7	0–5	95–100	95–100	90–100	80–90	35–55	15–30
	36–60	Clay loam, loam.	CL	A–4, A–6	0–5	95–100	90–100	85–100	60–80	30–40	10–20
Ethan part	0–9	Loam	CL, ML	A–4, A–6	0	95–100	90–100	80–95	55–80	30–40	5–25
	9–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0–5	90–100	85–100	75–100	50–95	25–50	5–25
HtA:[1] Homme part.	0–9	Silty clay loam.	CL	A–6, A–7	0	100	95–100	95–100	85–95	35–45	15–25
	9–24	Silty clay loam.	CL, CH	A–7	0	100	95–100	95–100	85–95	40–55	15–30
	24–36	Silty clay loam, silt loam.	CL, CH	A–6, A–7	0–5	95–100	95–100	90–100	80–90	35–55	15–30
	36–60	Clay loam, loam.	CL	A–4, A–6	0–5	95–100	90–100	85–100	60–80	30–40	10–20
Onita part	0–9	Silt loam	ML, CL	A–4, A–6	0	100	95–100	90–100	70–100	30–40	10–20
	9–32	Silty clay loam, silty clay.	CL, CH	A–6, A–7	0	100	95–100	90–100	85–100	35–60	10–35
	32–60	Silty clay loam, clay loam, silt loam.	CL, CH	A–6, A–7	0–5	95–100	95–100	85–100	65–100	30–55	10–30

See footnotes at end of table.

TABLE 9.—*Engineering properties and classifications*—Continued

Soil series and map symbols	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4 (4.7 mm)	10 (2.0 mm)	40 (0.42 mm)	200 (0.074 mm)		
	In				*Pct*					*Pct*	
HtB:[1] Homme part.	0–9	Silty clay loam.	CL	A–6, A–7	0	100	95–100	95–100	85–95	35–45	15–25
	9–24	Silty clay loam.	CL, CH	A–7	0	100	95–100	95–100	85–95	40–55	15–30
	24–36	Silty clay loam, silt loam.	CL, CH	A–6, A–7	0–5	95–100	95–100	90–100	80–90	35–55	15–30
	36–60	Clay loam, loam.	CL	A–4, A–6	0–5	95–100	90–100	85–100	60–80	30–40	10–20
Onita part	0–9	Silt loam	ML, CL	A–4, A–6	0	100	95–100	90–100	70–100	30–40	10–20
	9–32	Silty clay loam, clay loam, silty clay.	CL, CH	A–6, A–7	0	100	95–100	90–100	85–100	35–60	10–35
	32–60	Silty clay loam, clay loam, silt loam.	CL, CH	A–6, A–7	0–5	95–100	95–100	85–100	65–100	30–55	10–30
James: Ja	0–60	Silty clay	CL, CH, MH	A–7	0	100	100	90–100	85–95	45–80	20–50
Lamo: La	0–32	Silty clay loam.	CL, MH, CH	A–7	0	100	100	95–100	85–95	40–65	20–35
	32–60	Silty clay loam, silt loam.	CL, MH, CH	A–7	0	100	100	95–100	85–95	40–60	15–35
Lm:[1] Lamo part	0–32	Silty clay loam.	CL, MH, CH	A–7	0	100	100	95–100	85–95	40–65	20–35
	32–60	Silty clay loam, silt loam.	CL, MH, CH	A–7	0	100	100	95–100	85–95	40–60	15–35
Wann part	0–16	Loam	ML, CL	A–4	0	95–100	95–100	85–95	55–75	15–30	5–10
	16–60	Stratified sandy loam, fine sandy loam, loam.	SM, SM–SC	A–2, A–4	0	95–100	95–100	70–80	30–45	5–25	NP–5
Marsh: Ma. (Properties too variable to be estimated.)											
Onita: OaA	0–9	Silt loam	ML, CL	A–4, A–6	0	100	95–100	90–100	70–100	30–40	10–20
	9–32	Silty clay loam, clay loam, silty clay.	CL, CH	A–6, A–7	0	100	95–100	90–100	85–100	35–60	10–35
	32–60	Silty clay loam, clay loam, silt loam.	CL, CH	A–6, A–7	0–5	95–100	95–100	85–100	65–100	30–55	10–30
Prosper: PcA:[1] Prosper part.	0–13	Loam	CL, ML	A–4, A–6	0	95–100	95–100	85–100	60–90	30–40	10–20
	13–25	Clay loam, silty clay loam.	CL	A–6, A–7	0	95–100	95–100	85–100	60–90	35–50	10–30
	25–60	Clay loam, loam.	CL	A–4, A–6, A–7	0–5	95–100	95–100	80–90	55–85	30–50	8–30

See footnotes at end of table.

TABLE 9.—*Engineering properties and classifications*—Continued

Soil series and map symbols	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4 (4.7 mm)	10 (2.0 mm)	40 (0.42 mm)	200 (0.074 mm)		
	In				*Pct*					*Pct*	
Clarno part.	0–9	Loam	ML, CL	A–4, A–6	0	100	95–100	85–100	55–90	30–40	5–20
	9–36	Loam, clay loam.	CL	A–4, A–6, A–7	0	95–100	90–100	80–100	55–85	30–45	5–25
	36–60	Loam, clay loam.	CL–ML, CL	A–4, A–6, A–7	0	90–100	90–100	80–100	50–80	25–45	5–20
Pr:[1] Prosper part.	0–13	Loam	CL, ML	A–4, A–6	0	95–100	95–100	85–100	60–90	30–40	10–20
	13–25	Clay loam, silty clay loam.	CL	A–6, A–7	0	95–100	95–100	85–100	60–90	35–50	10–30
	25–60	Clay loam, loam.	CL	A–4, A–6, A–7	0–5	95–100	95–100	80–90	55–85	30–50	8–30
Stickney part.	0–15	Silty clay loam.	CL	A–6, A–7	0	100	100	95–100	85–95	40–47	15–25
	15–40	Clay loam, silty clay loam, clay.	CL, CH	A–6, A–7	0	100	95–100	85–100	65–95	35–60	14–35
	40–60	Clay loam, loam.	CL, CH	A–6, A–7	0–5	95–100	90–100	80–100	55–90	35–55	10–30
Ps:[1] Prosper part.	0–13	Loam	CL, ML	A–4, A–6	0	95–100	95–100	85–100	60–90	30–40	10–20
	13–25	Clay loam, silty clay loam.	CL	A–6, A–7	0	95–100	95–100	85–100	60–90	35–50	10–30
	25–60	Clay loam, loam.	CL	A–4, A–6, A–7	0–5	95–100	95–100	80–90	55–85	30–50	8–30
Crossplain part.	0–9	Clay loam	CL	A–4, A–6	0	100	100	90–100	70–80	30–40	9–20
	9–28	Clay loam, clay.	CL, CH	A–7	0	100	95–100	90–100	70–85	40–55	16–30
	28–60	Clay loam, loam.	CL	A–6, A–7	0	95–100	95–100	85–100	60–80	30–45	10–25
Redstoe: ReB	0–8	Silt loam	ML, MH	A–7, A–6	0	100	95–100	90–100	85–100	35–55	10–20
	8–27	Silt loam, silty clay loam.	ML, MH	A–7, A–6	0	100	100	95–100	85–100	40–55	10–20
	27–60	Weathered bedrock.									
Salmo: Sa	0–60	Silty clay loam.	ML, CL	A–4, A–6, A–7	0	100	100	90–100	70–95	30–45	7–25
Storla variant: St.	0–9	Loam	CL–ML, CL	A–4, A–6	0	100	95–100	85–95	60–75	25–35	5–15
	9–27	Loam, sandy loam.	ML, CL, SM, SC	A–4, A–6	0–5	90–100	90–100	60–95	35–75	20–35	5–15
	27–60	Sand and gravel.	GM, GM–GC, SM, SM–SC	A–1, A–2	0–5	45–90	40–90	20–60	15–35	<20	NP–5
Tetonka: Te	0–17	Silty clay loam.	CL	A–6, A–7	0	100	100	90–100	80–100	30–50	10–25
	17–42	Clay, silty clay, clay loam.	CL, CH	A–6, A–7	0	100	95–100	85–100	65–100	35–65	15–40
	42–60	Clay loam, silty clay, clay.	CL, CH	A–4, A–6, A–7	0	100	90–100	80–100	55–95	30–65	15–40

See footnotes at end of table.

TABLE 9.—*Engineering properties and classifications*—Continued

Soil series and map symbols	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4 (4.7 mm)	10 (2.0 mm)	40 (0.42 mm)	200 (0.074 mm)		
	In				*Pct*					*Pct*	
Tt:[1]											
Tetonka part.	0–17	Silty clay loam.	CL	A–6, A–7	0	100	100	90–100	80–100	30–50	10–25
	17–42	Clay, silty clay, clay loam.	CL, CH	A–6, A–7	0	100	95–100	85–100	65–100	35–65	15–40
	42–60	Clay loam, silty clay, clay.	CL, CH	A–4, A–6, A–7	0	100	90–100	80–100	55–95	30–65	15–40
Harps part	0–10	Loam	OL, CL, CH	A–6, A–7	0–5	100	95–100	80–90	65–80	30–55	20–40
	10–60	Loam, clay loam, sandy clay loam.	CL, CH	A–6, A–7	0–5	95–100	95–100	80–90	65–80	30–60	20–40
Tw:[1]											
Tetonka part.	0–17	Silty clay loam.	CL	A–6, A–7	0	100	100	90–100	80–100	30–50	10–25
	17–42	Clay, silty clay, clay loam.	CL, CH	A–6, A–7	0	100	95–100	85–100	65–100	35–65	15–40
	42–60	Clay loam, silty clay, clay.	CL, CH	A–4, A–6, A–7	0	100	90–100	80–100	55–95	30–65	15–40
Whitewood part.	0–26	Silty clay loam.	CL, CH, MH	A–6, A–7	0	100	100	95–100	80–95	35–55	15–30
	26–60	Silty clay loam.	CL, CH, MH	A–6, A–7	0	100	100	85–100	70–95	35–55	15–30
Wann: Wa	0–16	Loam	ML, CL	A–4	0	95–100	95–100	85–95	55–75	15–30	5–10
	16–60	Stratified sandy loam, fine sandy loam, loam.	SM, SM–SC	A–2, A–4	0	95–100	95–100	70–80	30–45	5–25	NP–5
Worthing: Ww.	0–16	Silty clay loam.	CL	A–7	0	100	100	95–100	85–95	42–50	17–26
	16–56	Silty clay	CH	A–7	0	100	100	95–100	85–100	50–70	22–40
	56–60	Silty clay, silty clay loam, clay loam.	CL, CH	A–7	0	100	95–100	90–100	70–95	35–60	20–35

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.
[2] NP means nonplastic.

ity of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 10. The estimated classification, without group index numbers, is given in table 9. Also in table 9 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO

soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Test Data

Table 10 shows the results of tests on selected horizons of 10 soils at specific locations in the survey area. The tests were made by the South Dakota Department of Transportation, Division of Highways, in accordance with the standard procedures of the AASHTO system of soil classification. Some of the terms used in table 10 that are not defined elsewhere are defined in the following paragraphs.

Maximum dry density is the maximum unit dry weight of a soil when compacted with optimum moisture by the prescribed method of compaction. The moisture content that gives the highest dry unit weight is the *optimum moisture content* for the specific method of compaction.

Mechanical analysis shows the percentage, by weight, of soil material that passes sieves of specified size. Sand and other coarse particles do not pass through the No. 200 sieve, but silt and clay do. The percentage of fractions smaller than those passing the No. 200 sieve was determined by the hydrometer method rather than by the pipette method that most soil scientists use in determining the clay content of soil samples.

Physical and Chemical Properties

Table 11 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 11. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reduc-

ing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions: (not all groups are represented in the survey area)

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.
6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and Water Features

Table 12 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

Most soils in low positions on the landscape, where flooding is likely to occur, are classified as fluvents at the suborder level or as fluventic subgroups. See the section "Classification of Soils."

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 12 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foun-

TABLE 10.—*Engineering*

[Tests performed by South Dakota Department

Soil name and location	Parent material	Depth	Horizon	Moisture-density [1]	
				Maximum dry density	Optimum moisture
		Inches		*Lb/cu ft*	*Pct*
Clamo silty clay loam:					
1,845 feet west and 450 feet north of SE corner of sec. 22, T. 99 N., R. 58 W. (Modal)	Clayey alluvium	11–15	B2g	105	18
		15–25	B31gca	90	27
		38–54	C2gcs	88	26
Clarno loam:					
1,520 feet west and 456 feet south of NE corner of sec. 26, T. 98 N., R. 57 W. (Modal)	Glacial till	11–15	B22	106	29
		25–32	B32ca	107	18
		41–60	C2csca	110	17
Crossplain loam:					
2,204 feet east and 175 feet south of NW corner of sec. 25, T. 100 N., R. 56 W. (Modal)	Local alluvium over glacial till.	9–15	B21tg	99	21
		28–36	C1ca	110	16
		48–60	C3	110	16
Dudley silt loam:					
1,380 feet north and 200 feet east of SW corner of sec. 27, T. 98 N., R. 57 W. (Modal)	Glacial till	13–18	B22t	102	20
		21–24	B31cs	107	19
		28–40	C1cacs	88	28
Egan silt loam:					
1,925 feet south and 250 feet east of NW corner of sec. 1, T. 97 N., R. 56 W. (Modal)	Silty drift over glacial till	13–19	B22	103	17
		23–33	C1ca	110	14
		33–50	IIC2	105	17
Hand loam:					
1,283 feet south and 450 feet east of NW corner of sec. 18, T. 100 N., R. 58 W. (Modal)	Glacial melt-water deposits over till.	9–17	B2	103	17
		24–31	B32ca	108	16
		31–40	C1	106	17
		52–60	C3	110	16
Lamo silty clay loam:					
1,100 feet west and 525 feet north of SE corner of sec. 2, T. 97 N., R. 58 W. (Modal)	Alluvium from James River.	12–18	AC1	99	20
		26–32	C1	101	20
		45–60	Ab	96	24
Prosper loam:					
2,332 feet north and 435 feet east of SW corner of sec. 5, T. 99 N., R. 60 W. (Modal)	Glacial till	18–25	B22t	107	17
		30–39	B3	112	15
		39–60	Cca	113	15
Stickney silty clay loam:					
1,120 feet west and 975 feet north of SE corner of sec. 36, T. 99 N., R. 57 W. (Modal)	Glacial till	15–18	B21t	95	25
		23–33	B23tcs	97	23
		40–50	C1csca	98	21
Wentworth silt loam:					
130 feet west and 2,160 feet north of SE corner of sec. 26, T. 98 N., R. 56 W. (Modal)	Silty drift over glacial till	8–15	B21	98	23
		19–31	B3ca	102	20
		43–60	IIC2	108	18

[1] Based on AASHTO designation T 99–57 (*1*).

[2] Mechanical analyses according to the AASHTO designation T 88 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is

test data

of Transportation, Division of Highways]

Mechanical analysis [2]					Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than 0.005 mm			AASHTO [3]	Unified [4]
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)					
----------	100	99	95	56	72	40	A-7-5(20)	MH-CH
----------	----------	100	97	60	72	40	A-7-5(20)	MH-CH
----------	100	98	94	58	79	45	A-7-5(20)	MH-CH
99	98	91	64	29	37	12	A-6(7)	CL-ML
99	97	91	69	35	38	19	A-6(10)	CL
98	96	88	63	27	36	18	A-6(9)	CL
----------	100	95	80	41	50	26	A-7-6(16)	CL
98	95	88	68	34	43	23	A-7-6(12)	CL
98	96	89	66	30	38	14	A-6(7)	CL-ML
99	99	95	76	40	50	21	A-7-6(14)	CL-ML
100	98	93	71	37	47	22	A-7-6(13)	CL-ML
99	97	91	70	35	48	21	A-7-6(12)	CL-ML
----------	100	99	94	34	45	12	A-7-5(10)	ML
100	99	95	79	30	34	11	A-6(8)	CL-ML
100	99	90	74	41	43	16	A-7-6(11)	CL-ML
99	98	90	63	27	39	12	A-6(6)	CL-ML
99	98	93	73	33	33	10	A-6(8)	CL-ML
----------	100	99	75	16	27	7	A-4(8)	CL-ML
99	97	90	64	21	32	11	A-6(7)	CL
----------	----------	100	81	32	40	17	A-6(11)	CL
----------	----------	100	83	26	37	7	A-4(8)	ML
----------	100	99	87	42	55	20	A-7-5(15)	MH
100	98	12	68	35	44	15	A-7-6(9)	ML
98	96	88	63	30	36	18	A-6(8)	CL
98	96	88	63	28	34	16	A-6(7)	CL
----------	100	99	92	46	59	28	A-7-5(19)	MH-CH
----------	100	98	86	40	52	18	A-7-5(13)	MH
100	99	95	76	49	58	25	A-7-5(18)	MH
----------	----------	100	98	42	50	20	A-7-5(14)	CL-ML
----------	100	99	93	46	44	19	A-7-6(13)	CL-ML
98	97	85	59	29	31	13	A-6(6)	CL

analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

[3] Based on AASHTO designation M 145-49 (*1*).

[4] Based on the Unified Soil Classification System (*2*).

TABLE 11.—*Physical and*

[Dashes indicate data were not available. The symbol < means less

Soil series and map symbols	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Betts:					
BeE:[1]					
Betts part	0–5	0.6–2.0	0.18–0.20	7.9–8.4	<2
	5–32	0.6–2.0	0.17–0.20	7.9–8.4	<2
	32–60	0.2–0.6	0.17–0.20	7.9–8.4	2–8
Ethan part	0–9	0.6–2.0	0.18–0.20	6.1–7.8	<2
	9–28	0.6–2.0	0.16–0.20	7.4–8.4	<2
	28–60	0.2–0.6	0.16–0.20	7.4–9.0	2–8
Bon: Bo	0–32	0.6–2.0	0.18–0.20	6.6–8.4	<2
	32–60	2.0–6.0	0.08–0.18	7.4–8.4	<2
Chaska: Ca,[1] Cb[1]	0–8	0.6–2.0	0.20–0.22	6.6–7.8	<2
	8–28	0.6–2.0	0.17–0.19	7.4–7.8	<2
	28–60	2.0–6.0	0.07–0.16	7.4–8.4	<2
Clamo: Cc	0–5	0.06–0.2	0.16–0.19	6.6–7.8	<2
	5–60	0.06–0.2	0.13–0.18	7.4–8.4	2–8
Clarno:					
CdA, CdB	0–9	0.6–2.0	0.18–0.20	6.1–7.3	<2
	9–36	0.6–2.0	0.16–0.20	6.6–8.4	<2
	36–60	0.2–0.6	0.16–0.20	7.4–9.0	2–8
CeA,[1] CeB:[1]					
Clarno part	0–9	0.6–2.0	0.18–0.20	6.1–7.3	<2
	9–36	0.6–2.0	0.16–0.20	6.6–8.4	<2
	36–60	0.2–0.6	0.16–0.20	7.4–9.0	2–8
Davison part	0–9	0.6–2.0	0.18–0.20	6.6–8.4	<2
	9–25	0.6–2.0	0.13–0.17	7.9–9.0	<2
	25–60	0.6–2.0	0.10–0.18	7.4–8.4	2–8
CnC:[1]					
Clarno part	0–9	0.6–2.0	0.18–0.20	6.1–7.3	<2
	9–36	0.6–2.0	0.16–0.20	6.6–8.4	<2
	36–60	0.2–0.6	0.16–0.20	7.4–9.0	2–8
Ethan part	0–9	0.6–2.0	0.18–0.20	6.1–7.8	<2
	9–60	0.2–2.0	0.16–0.20	7.4–9.0	2–8
CsA:[1]					
Clarno part	0–9	0.6–2.0	0.18–0.20	6.1–7.3	<2
	9–36	0.6–2.0	0.16–0.20	6.6–8.4	<2
	36–60	0.2–0.6	0.16–0.20	7.4–9.0	2–8
Stickney part	0–15	0.6–2.0	0.18–0.22	6.1–7.3	<2
	15–40	0.06–0.2	0.16–0.19	6.1–7.8	2–8
	40–60	0.06–0.6	0.14–0.18	7.4–8.4	4–12
Crossplain:					
Ct:[1]					
Crossplain part	0–9	0.2–0.6	0.19–0.22	6.1–7.8	<2
	9–28	0.06–0.6	0.11–0.17	6.1–7.8	<2
	28–60	0.06–0.6	0.16–0.20	6.6–8.4	2–8
Harps part	0–10	0.6–2.0	0.19–0.21	6.6–8.4	<2
	10–60	0.6–2.0	0.17–0.19	7.4–8.4	2–8
Davis: DaB, DaC	0–27	0.6–2.0	0.18–0.22	6.1–7.3	<2
	27–52	0.6–2.0	0.18–0.20	6.6–7.8	<2
	52–60	0.6–6.0	0.09–0.15	7.4–8.4	<2
Davison:					
DbA[1]	0–9	0.6–2.0	0.18–0.20	6.6–8.4	<2
	9–25	0.6–2.0	0.13–0.17	7.9–9.0	<2
	25–60	0.6–2.0	0.10–0.18	7.4–8.4	2–8

See footnote at end of table.

chemical properties of soils

than. The erosion tolerance factor (T) is for the entire profile]

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Moderate	Moderate	Moderate	0.28	5	4L
Moderate	High	Moderate	0.37		
Moderate	High	Moderate	0.37		
Moderate	Moderate	Low	0.28	5	6
Moderate	High	Moderate	0.37		
Moderate	High	Moderate	0.37		
Low	Low	Low			6
Low	Moderate	Low			
Moderate	High	Low			4L
Moderate	High	Low			
Low	High	Low			
High	High	Moderate			7
High	High	Moderate			
Low	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.37		
Moderate	High	Moderate	0.37		
Low	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.37		
Moderate	High	Moderate	0.37		
Moderate	Moderate	Low	0.28	5	4L
Moderate	High	Low	0.37		
Moderate	High	Moderate	0.37		
Low	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.37		
Moderate	High	Moderate	0.37		
Moderate	Moderate	Low	0.28	5	6
Moderate	High	Moderate	0.37		
Low	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.37		
Moderate	High	Moderate	0.37		
Moderate	Moderate	Low	0.37	3	6
High	High	Moderate	0.37		
High	High	High	0.37		
High	High	Low			6
High	High	Low			
High	High	Moderate			
Moderate	High	Low			4L
Moderate	High	Moderate			
Moderate	Moderate	Low	0.24	5	6
Moderate	Moderate	Low	0.37		
Moderate	Moderate	Low			
Moderate	Moderate	Low	0.28	5	4L
Moderate	High	Low	0.37		
Moderate	High	Moderate	0.37		

TABLE 11.—*Physical and chemical*

Soil series and map symbols	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
DcB:[1]					
Davison part	0–9	0.6–2.0	0.18–0.20	6.6–8.4	<2
	9–25	0.6–2.0	0.13–0.17	7.9–9.0	<2
	25–60	0.6–2.0	0.10–0.18	7.4–8.4	2–8
Onita part	0–9	0.6–2.0	0.19–0.22	5.6–7.3	<2
	9–32	0.2–0.6	0.11–0.17	6.1–7.3	<2
	32–60	0.2–0.6	0.17–0.20	7.4–8.4	<2
Delmont:					
DeA, DeB, DmB.[1]	0–16	0.6–2.0	0.18–0.20	6.6–7.8	<2
(Rock outcrop part of DmB is too variable to be estimated.)	16–60	6.0–20	0.03–0.06	7.4–8.4	<2
DnD:[1]					
Delmont part	0–16	0.6–2.0	0.18–0.20	6.6–7.8	<2
	16–60	6.0–20	0.03–0.06	7.4–8.4	<2
Talmo part	0–8	0.6–2.0	0.11–0.20	6.6–7.8	<2
	8–60	6.0–20	0.03–0.06	7.4–8.4	<2
Dimo: Do	0–9	0.6–2.0	0.18–0.20	5.6–7.3	<2
	9–26	0.6–2.0	0.09–0.18	6.1–7.3	<2
	26–40	6.0–20	0.03–0.06	7.4–8.4	<2
Dudley:					
DsA:[1]					
Dudley part	0–10	0.6–2.0	0.18–0.22	6.1–7.3	<2
	10–24	<0.2	0.13–0.19	6.6–9.0	4–16
	24–60	0.06–0.6	0.13–0.20	7.4–9.0	8–16
Stickney part	0–15	0.2–2.0	0.19–0.22	5.6–7.3	<2
	15–40	0.06–0.2	0.16–0.19	6.1–7.8	2–8
	40–60	0.06–0.6	0.14–0.18	7.4–8.4	4–12
Durrstein: Du	0–1	0.6–2.0	0.17–0.20	6.6–7.3	4–16
	1–18	<0.2	0.10–0.15	7.9–8.4	4–16
	18–56	<0.2	0.08–0.13	7.9–8.4	4–16
Egan:					
EaC	0–9	0.6–2.0	0.19–0.22	6.1–7.3	<2
	9–33	0.6–2.0	0.17–0.20	6.6–8.4	<2
	33–60	0.06–0.6	0.17–0.20	7.4–9.0	2–8
EbC2:[1]					
Egan part	0–8	0.6–2.0	0.19–0.22	6.1–7.3	<2
	8–33	0.6–2.0	0.17–0.20	6.6–8.4	<2
	33–60	0.06–0.6	0.17–0.20	7.4–9.0	2–8
Betts part	0–5	0.6–2.0	0.16–0.18	7.9–8.4	<2
	5–60	0.2–2.0	0.17–0.20	7.9–8.4	2–8
EgB:[1]					
Egan part	0–8	0.6–2.0	0.19–0.22	6.1–7.3	<2
	8–33	0.6–2.0	0.17–0.20	6.6–8.4	<2
	33–60	0.06–0.6	0.17–0.20	7.4–9.0	2–8
Wentworth part	0–10	0.6–2.0	0.19–0.22	5.6–7.3	<2
	10–26	0.6–2.0	0.18–0.21	6.1–7.3	<2
	26–60	0.6–2.0	0.17–0.20	7.4–8.4	2–8
Enet: EnA	0–24	0.6–2.0	0.18–0.20	6.1–7.3	<2
	24–28	0.6–2.0	0.11–0.20	6.6–7.8	<2
	28–60	6.0–20	0.03–0.06	7.4–8.4	<2

See footnote at end of table.

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Moderate	Moderate	Low	0.28	5	4L
Moderate	High	Low	0.37		
Moderate	High	Moderate	0.37		
Moderate	Moderate	Low	0.28	5	6
High	High	Low	0.28		
High	High	Low	0.43		
Low	Low	Low	0.28	3	6
Very low	Moderate	Low	0.10		
Low	Low	Low	0.28	3	6
Very low	Moderate	Low	0.10		
Low	Moderate	Low	0.20	2	8
Low	Moderate	Low	0.10		
Moderate	Low	Low	0.24	4	6
Moderate	High	Low	0.24		
Low	High	Low	0.10		
Moderate	Moderate	Low	0.43	3	6
High	High	Moderate	0.32		
Moderate	High	High	0.32		
Moderate	Moderate	Low	0.37	3	6
High	High	Moderate	0.37		
High	High	High	0.37		
Low	High	High	---	---	8
High	High	High	---		
High	High	High	---		
Moderate	Moderate	Low	0.32	5	6
Moderate	High	Low	0.32		
Moderate	High	Moderate	0.43		
Moderate	Moderate	Low	0.32	5	6
Moderate	High	Low	0.32		
Moderate	High	Moderate	0.43		
Moderate	Moderate	Moderate	0.32	3	4L
Moderate	High	Moderate	0.32		
Moderate	Moderate	Low	0.32	5	6
Moderate	High	Low	0.32		
Moderate	High	Moderate	0.43		
Moderate	Moderate	Low	0.32	5	6
Moderate	Moderate	Low	0.32		
Moderate	High	Moderate	0.43		
Low	Low	Low	0.28	4	6
Low	Moderate	Low	0.32		
Low	Moderate	Low	0.10		

TABLE 11.—*Physical and chemical*

Soil series and map symbols	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Ethan:					
EtB,[1] EtC2,[1] EtD:[1]					
Ethan part	0–9	0.6–2.0	0.18–0.20	6.1–7.8	<2
	9–60	0.2–2.0	0.16–0.20	7.4–9.0	2–8
Betts part	0–5	0.6–2.0	0.16–0.18	7.9–8.4	<2
	5–60	0.2–2.0	0.17–0.20	7.9–8.4	2–8
EuB,[1] EuC:[1]					
Ethan part	0–9	0.6–2.0	0.18–0.20	6.1–7.8	<2
	9–60	0.2–2.0	0.16–0.20	7.4–9.0	2–8
Clarno part	0–9	0.6–2.0	0.18–0.20	6.1–7.3	<2
	9–36	0.6–2.0	0.16–0.20	6.6–8.4	<2
	36–60	0.2–0.6	0.16–0.20	7.4–9.0	2–8
EwC:[1]					
Ethan part	0–9	0.6–2.0	0.18–0.20	6.1–7.8	<2
	9–60	0.2–2.0	0.16–0.20	7.4–9.0	2–8
Homme part	0–9	0.6–2.0	0.19–0.22	6.1–7.3	<2
	9–24	0.2–0.6	0.11–0.18	6.1–7.8	<2
	24–36	0.2–0.6	0.17–0.20	7.4–7.8	<2
	36–60	0.2–0.6	0.16–0.20	7.4–8.4	2–8
Fedora: Fa[1]	0–13	2.0–6.0	0.11–0.17	7.4–8.4	<2
	13–33	2.0–20	0.10–0.17	7.4–9.0	<2
	33–60	2.0–6.0	0.09–0.18	7.4–9.0	<2
Hand:					
HaA, HaB, HaC	0–17	0.6–2.0	0.18–0.20	5.6–7.3	<2
	17–31	0.6–2.0	0.18–0.22	6.1–8.4	<2
	31–60	0.6–2.0	0.12–0.18	7.4–8.4	<2
HbC:[1]					
Hand part	0–17	0.6–2.0	0.18–0.20	5.6–7.3	<2
	17–31	0.6–2.0	0.18–0.22	6.1–8.4	<2
	31–60	0.6–2.0	0.12–0.18	7.4–8.4	<2
Betts part	0–5	0.6–2.0	0.16–0.18	7.9–8.4	<2
	5–60	0.2–2.0	0.17–0.20	7.9–8.4	2–8
HcA:[1]					
Hand part	0–17	0.6–2.0	0.18–0.20	5.6–7.3	<2
	17–31	0.6–2.0	0.18–0.22	6.1–8.4	<2
	31–60	0.6–2.0	0.12–0.18	7.4–8.4	<2
Bonilla part	0–9	0.6–2.0	0.18–0.20	5.6–7.3	<2
	9–24	0.6–2.0	0.18–0.22	6.1–7.8	<2
	24–37	0.6–2.0	0.16–0.20	7.4–8.4	<2
	37–60	0.2–2.0	0.12–0.18	7.4–8.4	2–8
HdB:[1]					
Hand part	0–17	0.6–2.0	0.18–0.20	5.6–7.3	<2
	17–31	0.6–2.0	0.18–0.22	6.1–8.4	<2
	31–60	0.6–2.0	0.12–0.18	7.4–8.4	<2
Davison part	0–9	0.6–2.0	0.18–0.20	6.6–8.4	<2
	9–25	0.6–2.0	0.13–0.17	7.9–9.0	<2
	25–60	0.6–2.0	0.10–0.18	7.4–8.4	2–8
Henkin: HmA, HmB	0–19	2.0–6.0	0.11–0.17	5.6–7.3	<2
	19–34	2.0–6.0	0.09–0.18	6.1–8.4	<2
	34–60	2.0–6.0	0.08–0.16	6.1–8.4	<2
Henkin variant: HnB	0–23	2.0–6.0	0.11–0.17	6.1–7.3	<2
	23–60	6.0–20	0.03–0.06	6.6–7.8	<2

See footnote at end of table.

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Moderate	Moderate	Low	0.28	5	6
Moderate	High	Moderate	0.37		
Moderate	Moderate	Moderate	0.28	5	4L
Moderate	High	Moderate	0.37		
Moderate	Moderate	Low	0.28	5	6
Moderate	High	Moderate	0.37		
Low	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.37		
Moderate	High	Moderate	0.37		
Moderate	Moderate	Low	0.28	5	6
Moderate	High	Moderate	0.37		
Moderate	High	Low	0.32	5	7
High	High	Low	0.32		
Moderate	High	Low	0.32		
Moderate	High	Moderate	0.32		
Low	Low	Low			3
Low	Moderate	Low			
Low	Moderate	Low			
Moderate	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.43		
Moderate	High	Low	0.43		
Moderate	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.43		
Moderate	High	Low	0.43		
Moderate	Moderate	Moderate	0.28	5	4L
Moderate	High	Moderate	0.37		
Moderate	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.43		
Moderate	High	Low	0.43		
Low	Moderate	Moderate	0.24	5	6
Moderate	Moderate	Low	0.24		
Moderate	High	Low	0.43		
Moderate	High	Moderate	0.43		
Moderate	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.43		
Moderate	High	Low	0.43		
Moderate	Moderate	Low	0.28	5	4L
Moderate	High	Low	0.37		
Moderate	High	Moderate	0.37		
Low	Low	Low	0.20	5	3
Low	Moderate	Low	0.20		
Low	Moderate	Low	0.20		
Low	Moderate	Low	0.20	5	3
Low	Moderate	Low	0.10		

TABLE 11.—*Physical and chemical*

Soil series and map symbols	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Homme:					
HoC:[1]					
Homme part	0–9	0.6–2.0	0.19–0.22	6.1–7.3	<2
	9–24	0.2–0.6	0.11–0.18	6.1–7.8	<2
	24–36	0.2–0.6	0.17–0.20	7.4–7.8	<2
	36–60	0.2–0.6	0.16–0.20	7.4–8.4	2–8
Ethan part	0–9	0.6–2.0	0.18–0.20	6.1–7.8	<2
	9–60	0.2–2.0	0.16–0.20	7.4–9.0	2–8
HtA,[1] HtB:[1]					
Homme part	0–9	0.6–2.0	0.19–0.22	6.1–7.3	<2
	9–24	0.2–0.6	0.11–0.18	6.1–7.8	<2
	24–36	0.2–0.6	0.17–0.20	7.4–7.8	<2
	36–60	0.2–0.6	0.16–0.20	7.4–8.4	2–8
Onita part	0–9	0.6–2.0	0.19–0.22	5.6–7.3	<2
	9–32	0.2–0.6	0.11–0.17	6.1–7.3	<2
	32–60	0.2–0.6	0.17–0.20	7.4–8.4	<2
James: Ja	0–60	<0.2	0.10–0.19	7.4–9.0	4–20
Lamo:					
La	0–32	0.2–0.6	0.21–0.23	6.6–8.4	<2
	32–60	0.2–0.6	0.18–0.20	6.6–8.4	<2
Lm:[1]					
Lamo part	0–32	0.2–0.6	0.21–0.23	6.6–8.4	<2
	32–60	0.2–0.6	0.18–0.20	6.6–8.4	<2
Wann part	0–16	0.6–2.0	0.18–0.20	6.6–7.8	<2
	16–60	2.0–6.0	0.14–0.20	6.6–7.8	<2
Marsh: Ma. (Properties too variable to be estimated.)					
Onita: OaA	0–9	0.6–2.0	0.19–0.22	5.6–7.3	<2
	9–32	0.2–0.6	0.11–0.17	6.1–7.3	<2
	32–60	0.2–0.6	0.17–0.20	7.4–8.4	<2
Prosper:					
PcA:[1]					
Prosper part	0–13	0.6–2.0	0.18–0.22	6.1–7.8	<2
	13–25	0.6–2.0	0.19–0.22	6.6–7.8	<2
	25–60	0.2–0.6	0.17–0.20	7.4–8.4	2–8
Clarno part	0–9	0.6–2.0	0.18–0.20	6.1–7.3	<2
	9–36	0.6–2.0	0.16–0.20	6.6–8.4	<2
	36–60	0.2–0.6	0.16–0.20	7.4–9.0	2–8
Pr:[1]					
Prosper part	0–13	0.6–2.0	0.18–0.22	6.1–7.8	<2
	13–25	0.6–2.0	0.19–0.22	6.6–7.8	<2
	25–60	0.2–0.6	0.17–0.20	7.4–8.4	2–8
Stickney part	0–15	0.2–2.0	0.19–0.22	5.6–7.3	<2
	15–40	0.06–0.2	0.16–0.19	6.1–7.8	2–8
	40–60	0.06–0.6	0.14–0.18	7.4–8.4	4–12
Ps:[1]					
Prosper part	0–13	0.6–2.0	0.18–0.22	6.1–7.8	<2
	13–25	0.6–2.0	0.19–0.22	6.6–7.8	<2
	25–60	0.2–0.6	0.17–0.20	7.4–8.4	2–8
Crossplain part	0–9	0.2–0.6	0.19–0.22	6.1–7.8	<2
	9–28	0.06–0.6	0.11–0.17	6.1–7.8	<2
	28–60	0.06–0.6	0.16–0.20	6.6–8.4	2–8

See footnote at end of table.

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Moderate	High	Low	0.32	5	7
High	High	Low	0.32		
Moderate	High	Low	0.32		
Moderate	High	Moderate	0.32		
Moderate	Moderate	Low	0.28	5	6
Moderate	High	Moderate	0.37		
Moderate	High	Low	0.32	5	7
High	High	Low	0.32		
Moderate	High	Low	0.32		
Moderate	High	Moderate	0.32		
Moderate	Moderate	Low	0.28	5	6
High	High	Low	0.28		
High	High	Low	0.43		
High	High	High			4
High	High	Low			7
High	High	Low			
High	High	Low			7
High	High	Low			
Low	Moderate	Low			6
Low	High	Low			
Moderate	Moderate	Low	0.28	5	6
High	High	Low	0.28		
High	High	Low	0.43		
Moderate	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.28		
Moderate	High	Moderate	0.37		
Low	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.37		
Moderate	High	Moderate	0.37		
Moderate	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.28		
Moderate	High	Moderate	0.37		
Moderate	Moderate	Low	0.37	3	7
High	High	Moderate	0.37		
High	High	High	0.37		
Moderate	Moderate	Low	0.28	5	6
Moderate	Moderate	Low	0.28		
Moderate	High	Moderate	0.37		
High	High	Low			6
High	High	Low			
High	High	Moderate			

TABLE 11.—*Physical and chemical*

Soil series and map symbols	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Redstoe: ReB	0–8	0.6–2.0	0.15–0.19	6.6–8.4	<2
	8–27	0.6–2.0	0.13–0.17	6.6–8.4	<2
	27–60				
Salmo: Sa	0–60	0.2–0.6	0.19–0.22	6.6–8.4	4–16
Storla variant: St	0–9	0.6–2.0	0.18–0.20	6.6–8.4	<2
	9–27	0.6–6.0	0.09–0.18	7.4–8.4	<2
	27–60	6.0–20	0.03–0.06	7.4–8.4	<2
Tetonka:					
Te	0–17	0.2–0.6	0.19–0.22	5.6–7.3	<2
	17–42	<0.06	0.13–0.19	6.1–7.3	<2
	42–60	0.06–0.6	0.11–0.17	6.6–8.4	2–8
Tt:[1]					
Tetonka part	0–17	0.2–0.6	0.19–0.22	5.6–7.3	<2
	17–42	<0.06	0.13–0.19	6.1–7.3	<2
	42–60	0.06–0.6	0.11–0.17	6.6–8.4	2–8
Harps part	0–10	0.6–2.0	0.19–0.21	6.6–8.4	<2
	10–60	0.6–2.0	0.17–0.19	7.4–8.4	2–8
Tw:[1]					
Tetonka part	0–17	0.2–0.6	0.19–0.22	5.6–7.3	<2
	17–42	<0.06	0.13–0.19	6.1–7.3	<2
	42–60	0.06–0.6	0.11–0.17	6.6–8.4	2–8
Whitewood part	0–26	0.2–2.0	0.19–0.22	6.1–7.8	<2
	26–60	0.2–0.6	0.17–0.20	7.4–8.4	<2
Wann: Wa	0–16	0.6–2.0	0.18–0.20	6.1–7.8	<2
	16–60	2.0–6.0	0.14–0.20	6.6–7.8	<2
Worthing: Ww	0–16	0.2–0.6	0.19–0.22	5.6–7.3	<2
	16–56	0.06–0.2	0.13–0.18	6.1–7.3	<2
	56–60	0.2–0.6	0.11–0.17	7.4–8.4	2–8

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

dations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Formation and Classification of Soils

In this section the factors of soil formation are discussed and related to the formation of soils in the survey area. In addition, the system of soil classification currently used is explained, and the soils in the survey area are placed in categories of that system.

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Low	Moderate	Moderate	0.28	4	4L
Low	High	Moderate	0.43		
Moderate	High	High			4L
Moderate	Moderate	Low			4L
Low	Moderate	Low			
Low	Moderate	Low			
Moderate	Moderate	Moderate			7
High	High	Moderate			
High	High	Moderate			
Moderate	Moderate	Moderate			7
High	High	Moderate			
High	High	Moderate			
Moderate	High	Low			4L
Moderate	High	Moderate			
Moderate	Moderate	Moderate			7
High	High	Moderate			
High	High	Moderate			
Moderate	Moderate	Low			7
Moderate	High	Low			
Low	Moderate	Low			6
Low	High	Low			
High	Moderate	Moderate			7
High	High	Moderate			
High	High	Moderate			

Factors of Soil Formation

Soil is formed by the action of soil-forming processes on deposited or accumulated geologic material. The characteristics of the soil at any given location are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and developed; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors in soil formation. They act on parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. Much or little time may be involved, but some time is always required for the differentiation of soil horizons. The development of distinct horizons generally takes a long time.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

The oldest rock formation exposed in the survey area is Sioux Quartzite of Precambrian age. It is very hard and resistant to weathering. Sioux Quartzite is exposed at the surface in Hanson County mainly on the valley sides of upland drainageways. Some areas of Delmont soils are underlain by this rock at a moderate depth, but no soils in the county formed wholly in material that weathered from this rock.

The Niobrara Formation of Cretaceous age is the next oldest formation exposed in the survey area. It consists of soft siltstone and chalky shale. Soils form

TABLE 12.—*Soil*

[Dashes indicate the feature is not a concern. See text for descriptions of the hydrologic groups. The definitions of "flooding" and > means

Soil series and map symbols	Hydrologic group	Flooding		
		Frequency	Duration	Months
Betts: BeE[1]	B	None		
Bon: Bo	B	Common	Brief	Apr-Oct
Chaska: Ca,[1] Cb[1]	B	Common	Brief	Apr-Jun
Clamo: Cc	C	Common	Long	Mar-Oct
Clarno: CdA, CdB, CnC[1]	B	None		
CeA,[1] CeB:[1]				
Clarno part	B	None		
Davison part	B	None		
CsA:[1]				
Clarno part	B	None		
Stickney part	C	None		
Crossplain:				
Ct:[1]				
Crossplain part	C	Common	Brief	Sep-Jun
Harps part	B	None		
Davis: DaB, DaC	B	None to occasional	Very brief	Apr-Oct
Davison:				
DbA[1]	B	None		
DcB:[1]				
Davison part	B	None		
Onita part	C	None to common	Very brief	Oct-Jun
Delmont:				
DeA, DeB, DmB[1] (Rock outcrop part of DmB is too variable to be estimated.)	B	None		
DnD:[1]				
Delmont part	B	None		
Talmo part	A	None		
Dimo: Do	B	Common	Very brief	Mar-Oct
Dudley: DsA[1]	C	None		
Durrstein: Du	D	Common	Brief	Apr-Oct
Egan:				
EaC, EgB[1]	B	None		
EbC2:[1]				
Egan part	B	None		
Betts part	B	None		
Enet: EnA	B	None		
Ethan:				
EtB,[1] EtC2,[1] EtD,[1] EuB,[1] EuC.[1]	B	None		
EwC:[1]				
Ethan part	B	None		

See footnote at end of table.

and water features

"water table" in the Glossary explain the terms "rare," "brief," "apparent," and "perched." The symbol < means less than; greater than]

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0			>60		Moderate.
>6.0			>60		Moderate.
1.0–3.0	Apparent	Nov-Jun	>60		High.
2.0–3.0	Apparent	Oct-Jun	>60		High.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
1.5–6.0	Perched	Mar-Jun	>60		High.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
1.0–4.0	Perched	Sep-Jun	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		Moderate.
1.5–6.0	Perched	Mar-Jun	>60		High.
1.5–6.0	Perched	Mar-Jun	>60		High.
4.0–6.0	Perched	Oct-Jun	>60		Moderate.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
2.0–6.0	Apparent	Oct-Jun	>60		High.
>6.0			>60		Moderate.
1.0–6.0	Apparent	Oct-Jun	>60		High.
>6.0			>60		High.
>6.0			>60		High.
>6.0			>60		Moderate.
>6.0			>60		Low.
>6.0			>60		Moderate.
>6.0			>60		Moderate.

TABLE 12.—*Soil and*

Soil series and map symbols	Hydrologic group	Flooding		
		Frequency	Duration	Months
Homme part	C	None		
Fedora: Fa [1]	B	None		
Hand: HaA, HaB, HaC, HbC [1]	B	None		
HcA: [1]				
Hand part	B	None		
Bonilla part	B	Rare to common	Very brief	Apr-Oct
HdB: [1]				
Hand part	B	None		
Davison part	B	None		
Henkin: HmA, HmB	B	None		
Henkin variant: HnB	B	None		
Homme:				
HoC: [1]				
Homme part	C	None		
Ethan part	B	None		
HtA, [1] HtB: [1]				
Homme part	C	None		
Onita part	C	None to common	Very brief	Oct-Jun
James: Ja	D	Frequent	Long	Mar-Oct
Lamo:				
La	C	Occasional	Long	Mar-Aug
Lm: [1]				
Lamo part	C	Occasional	Long	Mar-Aug
Wann part	A	Occasional	Long	Mar-Nov
Marsh: Ma. (Properties too variable to be estimated.)				
Onita: OaA	C	None to common	Very brief	Oct-Jun
Prosper:				
PcA: [1]				
Prosper part	B	None to common	Very brief	Oct-Jun
Clarno part	B	None		
Pr: [1]				
Prosper part	B	None to common	Very brief	Oct-Jun
Stickney part	C	None		
Ps: [1]				
Prosper part	B	None to common	Very brief	Oct-Jun
Crossplain part	C	Common	Brief	Sep-Jun
Redstoe: ReB	B	None		
Salmo: Sa	C	Common	Brief	Mar-Oct
Storla variant: St	B	Rare		
Tetonka:				
Te	C	Common	Very long	Jan-Dec

See footnote at end of table.

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0			>60		Low.
1.0–4.0	Apparent	Oct-Jun	>60		High.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
4.0–6.0	Perched	Oct-Jun	>60		Moderate.
>6.0			>60		Moderate.
1.5–6.0	Perched	Mar-Jun	>60		High.
>6.0			>60		Moderate.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Moderate.
>6.0			>60		Low.
4.0–6.0	Perched	Oct-Jun	>60		Low.
1.0–2.0	Apparent	Oct-Jun	>60		High.
2.0–6.0	Apparent	Nov-May	>60		High.
2.0–6.0	Apparent	Nov-May	>60		High.
2.2–6.0	Apparent	Apr-Jun	>60		High.
4.0–6.0	Perched	Oct-Jun	>60		Low.
3.0–6.0	Perched	Oct-Jun	>60		Moderate.
>6.0			>60		Moderate.
3.0–6.0	Perched	Oct-Jun	>60		Moderate.
>6.0			>60		Moderate.
3.0–6.0	Perched	Oct-Jun	>60		Moderate.
1.0–4.0	Perched	Sep-Jun	>60		High.
>6.0			20–40	Rippable	Moderate.
0.5–2.5	Apparent	Sep-Jun	>60		High.
1.0–4.0	Perched	Mar-Jun	>60		High.
0–5.0	Perched	Jan-Dec	>60		High.

TABLE 12.—*Soil and*

Soil series and map symbols	Hydrologic group	Flooding		
		Frequency	Duration	Months
Tt:[1]				
Tetonka part	C	Common	Very long	Jan-Dec
Harps part	B	None		
Tw:[1]				
Tetonka part	C	Common	Very long	Jan-Dec
Whitewood part	C	Common	Very brief	Sep-Jun
Wann: Wa	A	Occasional	Brief	Mar-Nov
Worthing: Ww	D	Common	Very long	Jan-Dec

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

slowly in material that weathered from this formation because of the high content of lime. Redstoe soils in southwestern Hanson County formed in this material.

Most soils in the survey area formed in glacial material of late Wisconsin age that was derived from preglacial formations of granite, gneiss, limestone, sandstone, and shale. The glacier picked up materials from these formations, and it ground and mixed them as it transported and redeposited them. Some deposits consist of unsorted material or glacial till. Other deposits are glacial drift that was sorted either during deposition by water or after deposition by wind and water. Still other deposits were left by glacial melt water.

Glacial till is the most extensive parent material in the survey area. The texture ranges from loam to clay and the consistence from friable to firm. Cobbles and stones are scattered through the material and at the surface in places. Betts, Clarno, Dudley, Ethan, and Stickney soils formed in glacial till.

Glacial drift has a high content of silt but generally is finely stratified with silt and very fine sand. It is relatively free of stones. These silty deposits range from 2 to several feet in thickness. Egan, Homme, and Wentworth soils formed in glacial drift.

The glacial melt-water deposits have stratified layers that range from loam to gravelly sand or sand and gravel. The loam layers are stratified by thin layers of silt loam in places. Davison, Dimo, Delmont, Enet, Hand, Henkin, Storla, and Talmo soils formed in glacial melt-water deposits.

Crossplain, Onita, Prosper, Tetonka, and Worthing soils formed partly or wholly in local alluvium that washed from adjacent soils. The youngest parent material in the survey area is stream alluvium of the Holocene Epoch. Chaska, Clamo, Lamo, and Wann soils formed in stream alluvium.

Climate

The survey area has a continental climate that is characterized by cold winters and hot summers. The relatively cool temperatures favor the accumulation of organic matter in the upper layers of the soil. Periods of drought are followed by periods of higher than average precipitation; the soils, therefore, are alternately dry and moist. About 75 percent of the annual precipitation occurs during the growing season. The precipitation causes leaching of carbonates from the A and B horizons of most well drained soils. Although temperatures are about 1 degree cooler and precipitation is slightly more than 1 inch less in Hanson County than in Hutchinson County, the climate is relatively uniform throughout the survey area. Climate alone, therefore, does not account for differences in the soils of the survey area.

Plant and animal life

Plants, burrowing animals, insects, earthworms, bacteria, and fungi are all important in soil formation. The soils in the survey area formed under a vegetative cover of tall and mid grasses. The decomposition of roots and plant litter is aided by the climate, and this accounts for the moderate to high organic-matter content in the upper horizons of nearly level to undulating soils, such as the Clarno, Egan, Hand, Homme, and Wentworth soils. Earthworm activity has had some effect on moderately well drained to somewhat poorly drained soils such as the Bon, Lamo, Onita, and Prosper soils.

Relief

Relief influences soil formation through its effect on drainage, runoff, erosion, plant cover, and soil temperature. For example, steepness of slope causes the loss of much of the rainfall by runoff on some Betts soils. Because runoff is more rapid, the plant cover is less dense, the layer of accumulated organic matter is thinner, and natural erosion retards soil formation. On more gently sloping soils, for example, Clarno, Egan, Hand, and Wentworth soils, runoff is slower and more rainfall enters the soil. Onita and Prosper soils receive additional moisture as runoff from soils upslope. They have a thicker A horizon and generally are leached of carbonates to a greater depth than are well drained

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
0–5.0	Perched	Jan-Dec	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
0–5.0	Perched	Jan-Dec	>60		High.
0–5.0	Perched	Sep-Jun	>60		High.
2.2–6.0	Apparent	Apr-Jun	>60		High.
0–5.0	Perched	Jan-Dec	>60		High.

soils. The Tetonka and Worthing soils formed in flat-bottomed depressions where runoff is ponded.

Time

The length of time that soil material has been exposed to the other soil-forming factors determines the kinds of soil that form. Most of the soils in the survey area formed in glacial deposits of Wisconsin age and are relatively young compared to soils in the western part of the State. Examples of soils on the older landscapes of the survey area are the Clarno, Egan, Homme, and Wentworth soils. The youngest soils in the survey area are those that formed in stream alluvium of the Holocene Epoch, including the Chaska, Clamo, and Lamo soils.

Classification of Soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available (*6*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 13, the soils of the survey area are placed in two categories of the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water or wet, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplaquoll (*Hapl*, meaning simple horizons, *aqu* for wetness or water, and *oll*, from Mollisol).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. (See table 13.) An example is the coarse-loamy, mixed, mesic family of Typic Haplaquolls.

SERIES. The series consists of soils that formed in

TABLE 13.—*Classification of the soils*

[An asterisk in the first column indicates a taxadjunct to the series. See the series description for those characteristics that are outside the range of the series]

Soil series	Family or higher taxonomic class
Betts	Fine-loamy, mixed (calcareous), mesic Typic Ustorthents.
Bon	Fine-loamy, mixed, mesic Cumulic Haplustolls.
Bonilla	Fine-loamy, mixed, mesic Pachic Haplustolls.
*Chaska	Fine-loamy, mixed (calcareous), mesic Mollic Fluvaquents.
Clamo	Fine, montmorillonitic, mesic Cumulic Haplaquolls.
Clarno	Fine-loamy, mixed, mesic Typic Haplustolls.
Crossplain	Fine, montmorillonitic, mesic Typic Argiaquolls.
Davis	Fine-loamy, mixed, mesic Cumulic Haplustolls.
Davison	Fine-loamy, mesic Aeric Calciaquolls.
Delmont	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplustolls.
Dimo	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Pachic Haplustolls.
Dudley	Fine, montmorillonitic, mesic Typic Natrustolls.
Durrstein	Fine, montmorillonitic, mesic Typic Natraquolls.
Egan	Fine-silty, mixed, mesic Udic Haplustolls.
Enet	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Pachic Haplustolls.
Ethan	Fine-loamy, mixed, mesic Entic Haplustolls.
Fedora	Coarse-loamy, mesic Typic Calciaquolls.
Hand	Fine-loamy, mixed, mesic Typic Haplustolls.
Harps	Fine-loamy, mesic Typic Calciaquolls.
Henkin	Coarse-loamy, mixed, mesic Udic Haplustolls.
Henkin variant	Coarse-loamy, mixed, mesic Pachic Haplustolls.
Homme	Fine-silty, mixed, mesic Typic Haplustolls.
James	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls.
Lamo	Fine-silty, mixed (calcareous), mesic Cumulic Hapluquolls.
Onita	Fine, montmorillonitic, mesic Pachic Argiustolls.
Prosper	Fine-loamy, mixed, mesic Pachic Argiustolls.
Redstoe	Fine-silty, mixed, mesic Typic Calciustolls.
Salmo	Fine-silty, mixed (calcareous), mesic Cumulic Haplaquolls.
Stickney	Fine, montmorillonitic, mesic Glossic Natrustolls.
Storla variant	Fine-loamy over sandy or sandy-skeletal, mesic Typic Calciaquolls.
Talmo	Sandy-skeletal, mixed, mesic Udorthentic Haplustolls.
Tetonka	Fine, montmorillonitic, mesic Argiaquic Argialbolls.
*Wann	Coarse-loamy, mixed, mesic Fluvaquentic Haplustolls.
Wentworth	Fine-silty, mixed, mesic Udic Haplustolls.
*Whitewood	Fine-silty, mixed, mesic Cumulic Haplaquolls.
Worthing	Fine,montmorillonitic, mesic Typic Argiaquolls.

a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Environmental Factors Affecting Soil Use

In this section, some of the natural and cultural features that affect the use and management of the soils in Hanson and Hutchinson Counties are discussed.

Relief

Elevation ranges from less than 1,200 feet above mean sea level along the James River to 1,600 feet or more in the southwestern and southeastern parts of Hutchinson County. Except for the James River valley, the survey area is a glacial plain broken by many small closed depressions and by drainageways that are poorly defined in the upper reaches. The slopes are mostly nearly level in northern Hanson County and in the northwestern, west-central, and northeastern parts of Hutchinson County. The slopes are undulating to rolling in much of southern Hanson County and in the north-central part of Hutchinson County. The relief is gently rolling to hilly in the vicinity of terminal moraines in the extreme southeastern and southwestern parts of Hutchinson County. The breaks of the James River are hilly to steep.

Water

Shallow wells are a source of water for domestic and livestock use in most of the survey area. The quantity of water in most areas is limited, and the quality varies. The water generally is hard, but it is potable. Deep wells in northern Hanson County and in western Hutchinson County are at a depth of 400 to 900 feet. Some of the deep wells have an artesian flow and provide an abundant water supply of variable quality.

Surface water in the survey area consists mainly of the James River and its principal tributaries. Long Lake, Silver Lake, and Spring Lake are small natural lakes in the area. These bodies of water and dugouts and impoundments in drainageways are additional

sources of livestock water. Ethan Lake, Hanson Lake, Lake Dimock, Lake Menno, and Tripp Lake are small manmade lakes that are used mainly for recreation.

Climate [8]

The climate of the survey area is humid continental and approaches semi-arid in some years. Neither large bodies of water nor topography affect it. Climate data are based on records from Menno in Hutchinson County and from Alexandria in Hanson County. The data in tables 14 and 15 are averages for the two counties. Because Alexandria is further north, the temperatures are lower and rainfall is less than in Menno. Average monthly and annual temperatures at Alexandria are about 1 degree below those shown in table 14; averages at Menno are about 1 degree above those shown. The average annual rainfall is 24.26 inches at Menno and 21.82 inches at Alexandria.

There is a wide range in temperature from summer to winter and in daily maximum and minimum temperatures during most of the year. Temperatures occasionally rise to more than 100° in summer or fall to −30° or lower in winter. They generally rise to more than 100° on at least 3 days each year—twice in July and once in August—and they rise to more than 90° on about 35 days each year. A temperature of −20° or less occurs at least once each January and once every 2 years in December or February. Temperatures of 30 degrees below zero or lower occur once every 3 years. On 28 days in a year the minimum temperature drops below zero, and on 3 days the maximum temperature is at or below zero.

Table 15 shows the probability of specified low temperatures after specific dates in spring and before specific dates in fall. According to this table, there is a 50 percent chance that a 32°F temperature will occur after May 8 or before September 30. The data refer to air temperature measured in a standard shelter. Soil and plant temperature will vary somewhat from the free air temperature.

Annual rainfall in this area ranges from a maximum of 39.62 inches (in 1944) to a minimum of 14.71 inches (in 1966). In most years, 75 percent of the annual rainfall comes during the growing season. There is rain on an average of 56 days a year. During the growing season the main source of rain is thunderstorms that vary in intensity and amount. Rainfall of 1 inch or more an hour can be expected at least once a year. Rainfall of 2 inches or more an hour can be expected once in 6 or 7 years. About once a year, rainfall of 2 inches in 24 hours is expected; about once in 5 years, rainfall of 3 inches in 24 hours can be expected.

The average annual snowfall in this area is 36.6 inches. The greatest snowfall was 83.5 inches in 1961–62, and the least was 18.4 inches in the 1962–63 season. The greatest monthly snowfall was 49.8 inches in February 1962. The greatest daily snowfall was 19 inches on March 10, 1956. Strong winds often accompany snow, and large drifts pile up in or near sheltered areas although exposed fields may be nearly free of snow.

Although records of sunshine, wind, and relative humidity are not kept at Alexandria or Menno, data recorded at Sioux Falls and Huron can be used to estimate conditions in the survey area. The sun shines about 67 percent of the time possible during the growing season. The highest percentage of sunshine is 77 percent, in July, and the lowest amount is 50 percent, in December. The windspeed averages 11 miles an hour from the south in summer and 12 miles an hour from the northwest in winter. Windspeeds as high as 50 miles an hour are most likely to occur in summer during a thunderstorm. Thunderstorms occur on an average of 10 days in June and July and on 3 or 4 days in April, May, August, and September. They occur on an average of 43 days annually.

Hail can be expected to accompany thunderstorms about three times a year in this area, and the probability is greatest in June.

The relative humidity in the survey area varies greatly from morning to afternoon. The annual average is 82 percent humidity at 6 a.m. and 60 percent in the afternoon.

The water lost by soil and crops through evaporation is measured by an evaporation pan. The average annual evaporation indicated by the Weather Bureau Class A pan is 52 inches in the survey area. Most of this—41 inches—occurs from May through October. The average evaporation from small lakes is 37 inches; and the loss from soils and crops is generally less than this, depending on the available moisture in the soil.

Cultural Features

Hutchinson County was created in 1862 and Hanson County in 1871 by acts of the Dakota Territory legislature. The boundaries of Hutchinson County remain as determined by the 1879 legislature. The Hanson County boundaries have remained constant since 1881. Olivet was made the county seat of Hutchinson County in 1873; Alexandria became the county seat of Hanson County in 1880 after the original county seat, Rockport, was bypassed by the railroad.

The counties were settled rapidly. In 1890 the population of Hanson County was 4,267 and that of Hutchinson County was 10,469. The population increased slightly until 1930, but it has decreased slightly since then. Increases in some of the larger towns have been offset by decreases in the population on farms and in small towns. In 1970 the population of Hanson County was 3,781 and that of Hutchinson County was 10,379. According to the U.S. Bureau of the Census, 61.3 percent of the population in Hanson County and 41.2 percent in Hutchinson County live on farms. A significant part of the farm population in the survey area consists of communal settlements of Hutterites referred to as "colonies." The Rockport and Rosedale colonies are in Hanson County, and the Elm Springs, Marcy, Maxwell, Tschetter, and Wolf Creek colonies are in Hutchinson County.

The largest town in Hanson County, Alexandria, has a population of 598. Other towns in this county are Farmer, Fulton, and Emery. Plano and Riverside are

[8] By WILLIAM F. LYTLE, associate professor, South Dakota State University.

TABLE 14.—*Temperature and precipitation data*

[Data recorded at Alexandria and Menno for the period 1941 to 1970]

Month	Temperature				Precipitation						Average number of days that have—	
			Two years in 10 will have—					One year in 10 will have—				
	Average daily maximum	Average daily minimum	Average maximum equal to or higher than—	Average minimum equal to or lower than—	Average	Maximum	Minimum	Less than—	More than—	Average snowfall	Snowfall of 1 inch or more	Snow cover of 1 inch or more
	°F	°F	°F	°F	In	In	In	In	In	In		
January	27.9	5.4	36.0	−2.1	0.41	1.29	0.04	0.09	0.84	5.3	1	10
February	33.5	11.2	40.5	4.5	.70	2.62	.08	.14	1.42	7.7	2	8
March	42.8	21.0	52.8	13.7	1.21	3.14	.14	.42	2.22	9.5	2	5
April	61.2	35.5	68.2	31.3	2.21	4.85	.57	.82	3.91	2.0	0	0
May	72.8	46.5	77.8	42.2	3.17	6.30	.82	1.19	5.58	.2	0	0
June	81.2	56.8	86.8	53.4	4.29	8.37	1.31	2.00	7.00	0	0	0
July	87.7	61.9	92.2	58.6	3.05	8.97	.47	1.03	5.56	0	0	0
August	86.5	60.1	90.6	56.6	2.67	7.50	.77	1.16	4.50	0	0	0
September	76.3	49.7	81.2	46.0	2.43	5.92	.49	.94	4.28	0	0	0
October	66.0	38.4	72.0	35.4	1.51	4.15	.09	.18	3.30	.3	0	0
November	46.9	23.9	53.2	19.1	.75	2.47	0	.09	1.65	5.1	1	2
December	32.9	11.8	39.8	5.5	.56	1.84	0	.07	1.22	6.5	1	7
Year	59.6	35.2	61.9	33.4	23.04	[1] 39.62	[2] 14.71	17.59	29.33	36.6	7	32

[1] In 1944.
[2] In 1966.

rural settlements. The largest towns in Hutchinson County are Parkston with a population of 1,611 and Freeman with a population of 1,357. Other towns and villages in this county are Beardsley, Clayton, Dimock, Kaylor, Menno, Milltown, Olivet, and Tripp.

Two railroads provide freight service to Alexandria, Emery, Farmer, and Fulton in Hanson County and to Dimock, Freeman, Menno, Parkston, and Tripp in Hutchinson County. Interstate Highway 90 crosses Hanson County from east to west. Other main highways in the survey area are U.S. Highways 16, 18, and 81 and State Highways 25, 35, 37, 38, 42, and 44. Township and county roads are on almost every section line. Many of the county roads have an asphalt surface or are graveled, and most rural areas are served by all-weather roads. Commercial airline service is available at Mitchell in adjacent Davison County and at Sioux Falls.

TABLE 15.—*Probability of damaging temperatures in spring and fall*

[Data recorded at Alexandria and Menno for the period 1941 to 1970]

Probability	Dates for given probability and temperature					
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower	36° F or lower
After a specified date in spring:						
90 percent	March 10	March 18	March 23	April 5	April 17	May 2
70 percent	March 17	March 24	April 1	April 13	April 25	May 9
50 percent	March 28	April 6	April 14	April 26	May 8	May 20
30 percent	April 8	April 18	April 29	May 10	May 21	May 31
10 percent	April 14	April 25	May 7	May 17	May 29	June 6
Before a specified date in fall:						
10 percent	October 14	October 12	October 3	September 20	September 12	September 4
30 percent	October 24	October 19	October 11	October 3	September 19	September 11
50 percent	November 4	October 30	October 23	October 10	September 30	September 21
70 percent	November 18	November 10	November 5	October 18	October 11	October 3
90 percent	November 25	November 17	November 13	October 28	October 18	October 10

Menno has a livestock auction barn, but many of the livestock are marketed outside the survey area at auction barns in adjacent counties or at central markets in Sioux Falls and Sioux City. Grain is marketed in Alexandria, Dimock, Farmer, Fulton, Freeman, Menno, Parkston, and Tripp and in adjacent counties. Cheese factories in Freeman and Parkston and dairy processing plants in Mitchell provide markets for milk producers. Alexandria and Emery in Hanson County and Freeman, Menno, Parkston, and Tripp in Hutchinson County are the main trading centers for farm equipment, hardware, and other farm supplies. Mitchell, in adjacent Davison County, also is an important trading center for farmers in the survey area.

Trends in Soil Use

Since the drought and depression of the 1930's, the number of farms has decreased steadily and the average size of farms has increased. In 1935, Hanson County had 980 farms with an average size of 284 acres, and Hutchinson County had 1,805 farms with an average size of 280 acres. According to the U.S. Census of Agriculture, in 1969 the number of farms in Hanson County had declined to 559 and the average size had increased to 446 acres, and Hutchinson County had 1,328 farms with an average size of 383 acres.

Farming in these counties was diversified from the time of settlement until about 1945. Since then, there has been a steady increase in the raising and feeding of beef cattle and hogs. In 1974, about 84 percent of all farm income was from the sale of livestock and livestock products. In the years preceding 1945, cattle numbered 60,000 to 75,000, of which more than a third were cows and heifers kept for milk production. In 1974 there were 152,000 cattle on farms in the survey area, only 8,700 of which were cows and heifers kept for dairy purposes. In addition, there were 119,000 hogs, 15,600 sheep, and 361,300 chickens.

Corn is the most important crop in the survey area. Other important crops are oats, alfalfa, sorghum, and soybeans. In 1974 there were 235,000 acres of corn planted, 153,000 acres of oats, 15,700 acres of sorghum, and 13,300 acres of soybeans and 41,100 acres of alfalfa were cut for hay. Smaller acreages were planted to barley, spring wheat, and rye. In the past 30 years, corn, oats, and alfalfa have increased in acreage, and sorghum and soybeans have become important crops. Meanwhile, the acreage planted to barley and spring wheat, which had been major crops, is now of minor extent.

Additional information on past history of cropping and livestock raising can be obtained from the annual reports of the South Dakota Crop and Livestock Reporting Service (*4*).

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Crop residue use. A system of retaining crop residue on land between harvest and replanting to prevent erosion and insure future crop production.

Diversion (or diversion terrace). A ridge of earth, generally a

terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Emergency tillage. Cultivation by listing, ridging, duckfooting, chiseling, pitting, basin listing, or other means to roughen the soil surface for temporary control of soil blowing.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. None means that flooding is not probable; rare that it is unlikely but possible under unusual weather conditions; occasional that it occurs on an average of once or less in 2 years; and frequent that it occurs on an average of more than once in 2 years. Duration is expressed as very brief if less than 2 days, brief if 2 to 7 days, and long if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the assorted and unassorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Organic matter. Plant and animal material in or on the soil in all stages of decomposition. Readily decomposed organic matter is often distinguished from more stable forms that

are past the stage of rapid decomposition. The classes of organic matter, based on the percent of organic matter in the upper ten inches of soil, are *very low*, less than 0.5 percent; *low*, 0.5 to 1.0 percent; *moderately low*, 1.0 to 2.0 percent; *moderate*, 2.0 to 4.0 percent; *high*, 4.0 to 8.0 percent; and *very high*, 8.0 to 16.0 percent.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Proper grazing use. Grazing rangeland or pastureland at such intensity that the quality of the vegetation will not deteriorate and the amount of plant residue will be sufficient to conserve soil and water.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		pH
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Salts. Products other than water that result when an acid reacts with a base. Salts commonly found in soils break up into cations (sodium, calcium, and others) and anions (chloride, sulphate, and others) when dissolved in water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthly parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Wind stripcropping. Growing crops in strips planted at a right angle to the general direction of the prevailing wind and without strict adherence to the contour of the land.

GUIDE TO MAPPING UNITS

Absence of an entry indicates that the mapping unit is not placed in the specified grouping or that individual soils of a mapping unit are designated separately. For a full description of a mapping unit, read the description of the mapping unit and that of the soil series to which the mapping unit belongs. Pasture groups are described on pages 61 through 63. Range sites are described beginning on page 63. Windbreak groups are described beginning on page 68.

Map symbol	Mapping unit	Page	Capability unit		Pasture group	Range site	Windbreak group
			Symbol	Page	Letter	Name	Number
BeE	Betts and Ethan loams, 15 to 40 percent slopes----	12	------	--	-	----------	10
	Betts part----------	--	VIIe-1	61	-	Thin Upland	--
	Ethan part----------	--	VIe-3	61	G	Silty	--
Bo	Bon loam----------	13	I-1	55	K	Overflow	1
Ca	Chaska soils----------	14	IIw-3	57	A	Subirrigated	2
Cb	Chaska soils, channeled----------	15	VIw-1	61	A	Subirrigated	10
Cc	Clamo silty clay loam----------	16	IIw-3	57	A	Subirrigated	2
CdA	Clarno loam, 0 to 3 percent slopes----------	16	I-2	55	F	Silty	3
CdB	Clarno loam, 3 to 6 percent slopes----------	17	IIe-2	55	F	Silty	3
CeA	Clarno-Davison loams, 0 to 2 percent slopes-------	17	------	--	F	Silty	--
	Clarno part----------	--	I-2	55	-	----------	3
	Davison part----------	--	IIe-4	56	-	----------	1
CeB	Clarno-Davison loams, 2 to 4 percent slopes-------	17	------	--	F	Silty	--
	Clarno part----------	--	IIe-2	55	-	----------	3
	Davison part----------	--	IIIe-8	58	-	----------	1
CnC	Clarno-Ethan loams, 6 to 9 percent slopes---------	17	------	--	-	Silty	--
	Clarno part----------	--	IIIe-1	57	F	----------	3
	Ethan part----------	--	IVe-2	59	G	----------	8
CsA	Clarno-Stickney loams, 0 to 2 percent slopes------	18	------	--	-	----------	--
	Clarno part----------	--	I-2	55	F	Silty	3
	Stickney part----------	--	IIs-1	57	E	Clayey	4
Ct	Crossplain-Harps complex----------	19	IIw-1	57	A	----------	2
	Crossplain part----------	--	------	--	-	Overflow	--
	Harps part----------	--	------	--	-	Subirrigated	--
DaB	Davis loam, 2 to 6 percent slopes----------	20	IIe-1	55	K	Silty	1
DaC	Davis loam, 6 to 9 percent slopes----------	20	IIIe-2	58	K	Silty	1
DbA	Davison soils, 0 to 3 percent slopes----------	21	IIe-4	56	F	Silty	1
DcB	Davison-Onita complex, 2 to 6 percent slopes------	21	------	--	-	Silty	1
	Davison part----------	--	IIIe-8	58	F	----------	--
	Onita part----------	--	IIe-1	55	K	----------	--
DeA	Delmont loam, 0 to 3 percent slopes----------	22	IIIs-3	59	D	Shallow to Gravel	10
DeB	Delmont loam, 3 to 6 percent slopes----------	22	IVs-2	60	D	Shallow to Gravel	10
DmB	Delmont-Rock outcrop complex, 2 to 9 percent slopes----------	22	------	--	-	----------	--
	Delmont part----------	--	VIe-6	61	D	Shallow to Gravel	10
	Rock outcrop part----------	--	VIIIs-1	61	-	----------	--
DnD	Delmont-Talmo complex, 6 to 12 percent slopes-----	22	VIe-6	61	-	----------	10
	Delmont part----------	--	------	--	D	Shallow to Gravel	--
	Talmo part----------	--	------	--	-	Very Shallow	--
Do	Dimo loam----------	23	IIs-3	57	D	Overflow	3
DsA	Dudley-Stickney complex, 0 to 2 percent slopes----	25	------	--	-	----------	--
	Dudley part----------	--	IVs-3	60	C	Claypan	9
	Stickney part----------	--	IIs-1	57	E	Clayey	4
Du	Durrstein silt loam----------	26	VIw-3	61	J	Saline Lowland	10
EaC	Egan silt loam, 6 to 9 percent slopes----------	27	IIIe-2	58	F	Silty	3
EbC2	Egan-Betts complex, 3 to 9 percent slopes, eroded-	27	------	--	-	----------	--
	Egan part----------	--	IVe-1	59	F	Silty	3
	Betts part----------	--	VIe-3	61	G	Thin Upland	10
EgB	Egan and Wentworth silt loams, 2 to 6 percent slopes----------	27	IIe-3	56	F	Silty	3
EnA	Enet loam, 0 to 2 percent slopes----------	28	IIs-3	56	D	Silty	6

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Pasture group	Range site	Windbreak group
			Symbol	Page	Letter	Name	Number
EtB	Ethan-Betts loams, 3 to 6 percent slopes	29	IIIe-6	58	G		8
	Ethan part	--	------	--	-	Silty	--
	Betts part	--	------	--	-	Thin Upland	--
EtC2	Ethan-Betts loams, 6 to 9 percent slopes, eroded	29	VIe-3	61	G		10
	Ethan part	--	------	--	-	Silty	--
	Betts part	--	------	--	-	Thin Upland	--
EtD	Ethan-Betts loams, 9 to 15 percent slopes	29	VIe-3	61	G		10
	Ethan part	--	------	--	-	Silty	--
	Betts part	--	------	--	-	Thin Upland	--
EuB	Ethan-Clarno loams, 2 to 6 percent slopes	29	------	--	-	Silty	--
	Ethan part	--	IIIe-6	58	G		8
	Clarno part	--	IIe-2	55	F		3
EuC	Ethan-Clarno loams, 6 to 9 percent slopes	30	------	--	-	Silty	--
	Ethan part	--	IVe-2	59	G		8
	Clarno part	--	IIIe-1	57	F		3
EwC	Ethan-Homme complex, 6 to 9 percent slopes	30	------	--	-	Silty	--
	Ethan part	--	IVe-2	59	G		8
	Homme part	--	IIIe-2	58	F		3
Fa	Fedora soils	31	IIIw-4	59	A	Subirrigated	2
HaA	Hand loam, 0 to 3 percent slopes	32	I-2	55	F	Silty	3
HaB	Hand loam, 3 to 6 percent slopes	32	IIe-2	55	F	Silty	3
HaC	Hand loam, 6 to 9 percent slopes	33	IIIe-1	57	F	Silty	3
HbC	Hand-Betts loams, 6 to 9 percent slopes	33	------	--	-		--
	Hand part	--	IIIe-1	57	F	Silty	3
	Betts part	--	IVe-2	59	G	Thin Upland	8
HcA	Hand-Bonilla loams, 0 to 3 percent slopes	33	I-2	55	-		--
	Hand part	--	------	--	F	Silty	3
	Bonilla part	--	------	--	K	Overflow	1
HdB	Hand-Davison loams, 3 to 6 percent slopes	33	------	--	F	Silty	--
	Hand part	--	IIe-2	55	-		3
	Davison part	--	IIIe-8	58	-		1
HmA	Henkin fine sandy loam, 0 to 2 percent slopes	35	IIIs-1	59	H	Sandy	5
HmB	Henkin fine sandy loam, 2 to 6 percent slopes	35	IIIe-7	58	H	Sandy	5
HnB	Henkin variant fine sandy loam, 0 to 6 percent slopes	36	IVe-3	60	D	Sandy	6
HoC	Homme-Ethan complex, 6 to 9 percent slopes	37	------	--	-	Silty	--
	Homme part	--	IIIe-2	58	F		3
	Ethan part	--	IVe-2	59	G		8
HtA	Homme-Onita complex, 0 to 2 percent slopes	37	I-2	55	-		--
	Homme part	--	------	--	F	Silty	3
	Onita part	--	------	--	K	Overflow	1
HtB	Homme-Onita complex, 2 to 6 percent slopes	37	IIe-3	56	-	Silty	--
	Homme part	--	------	--	F		3
	Onita part	--	------	--	K		1
Ja	James silty clay	38	IVw-2	60	J	Saline Lowland	10
La	Lamo silty clay loam	39	IIw-3	57	A	Subirrigated	2
Lm	Lamo-Wann complex, frequently flooded	39	IVw-2	60	B	Subirrigated	2
Ma	Marsh	40	------	--	-		--
OaA	Onita silt loam, 0 to 3 percent slopes	41	I-3	55	K	Overflow	1
PcA	Prosper-Clarno loams, 0 to 2 percent slopes	42	I-3	55	-		--
	Prosper part	--	------	--	K	Overflow	1
	Clarno part	--	------	--	F	Silty	3
Pr	Prosper-Stickney complex	42	------	--	-		--
	Prosper part	--	I-3	55	K	Overflow	1
	Stickney part	--	IIs-1	57	E	Clayey	4
Ps	Prosper and Crossplain soils	43	------	--	-	Overflow	--
	Prosper part	--	I-3	55	K		1
	Crossplain part	--	IIw-1	57	A		2
ReB	Redstoe silt loam, 0 to 6 percent slopes	44	IIIe-6	58	G	Thin Upland	8

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Pasture group	Range site	Windbreak group
			Symbol	Page	Letter	Name	Number
Sa	Salmo silty clay loam	44	IVw-2	60	J	Saline Lowland	10
St	Storla variant loam	47	IVw-2	60	A	Subirrigated	2
Te	Tetonka silty clay loam [1]	49	IIw-1 [2]	57	A [2]	Wetland	10
			IVw-2 [3]	60	B [3]	----------	--
Tt	Tetonka-Harps complex	49	IIw-1	57	A	----------	--
	Tetonka part	--	------	--	-	Wetland	10
	Harps part	--	------	--	-	Subirrigated	2
Tw	Tetonka and Whitewood silty clay loams	49	IIw-1	57	A	----------	--
	Tetonka part	--	------	--	-	Wetland	10
	Whitewood part	--	------	--	-	Overflow	2
Wa	Wann loam	50	IIIw-4	59	A	Subirrigated	2
Ww	Worthing silty clay loam [1]	53	IIIw-1 [2]	58	A	Wetland	10
			Vw-2 [3]	60	B	----------	--

[1] Status of artificial drainage and feasibility of drainage determined by onsite inspection.

[2] Drained.

[3] Undrained.

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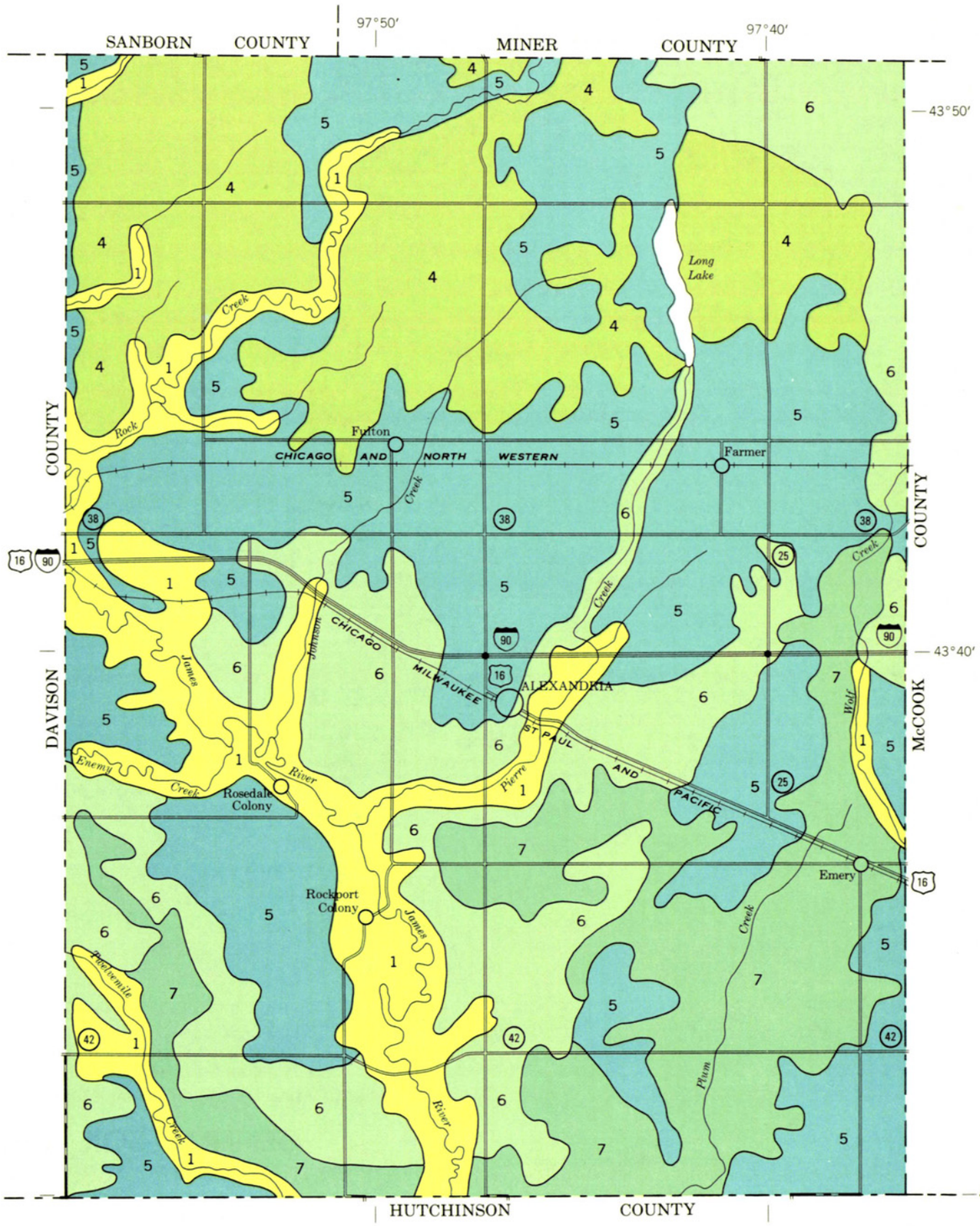


Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

N

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

HANSON COUNTY, SOUTH DAKOTA

Scale 1:190,080

1 0 1 2 3 4 Miles

SOIL ASSOCIATIONS

1 — Ethan-Betts-Chaska association: Well drained to excessively drained, rolling to steep, loamy soils that formed in glacial till on uplands; and somewhat poorly drained and poorly drained, nearly level, silty and loamy soils on bottom land

2 — Homme-Onita-Whitewood association: Well drained to somewhat poorly drained, nearly level to moderately sloping, silty soils that formed in glacial drift and alluvium on uplands

3 — Egan-Wentworth association: Well drained, gently sloping and moderately sloping, silty soils that formed in glacial drift on uplands

4 — Prosper-Clarno-Stickney association: Moderately well drained and well drained, nearly level to undulating, loamy and silty soils that formed in alluvium and glacial till on uplands

5 — Clarno-Tetonka-Prosper association: Well drained, poorly drained, and moderately well drained, level to undulating, loamy and silty soils that formed in glacial till and alluvium on uplands

6 — Clarno-Ethan-Tetonka association: Well drained and poorly drained, level to rolling, loamy and silty soils that formed in glacial till and alluvium on uplands

7 — Hand-Clarno-Davison association: Well drained and moderately well drained, nearly level to gently rolling, loamy soils that formed in glacial melt-water deposits and glacial till on uplands

8 — Crossplain-Clarno-Tetonka association: Poorly drained and well drained, nearly level and level, loamy and silty soils that formed in glacial till and alluvium on uplands

Compiled 1977

98°00′ 97°50′ 97°40′ 97°30′

43°30′

DAVISON COUNTY | HANSON COUNTY | McCOOK COUNTY

DOUGLAS COUNTY

TURNER COUNTY

43°20′

CHARLES MIX COUNTY

BON HOMME COUNTY | YANKTON COUNTY

Dimock
Parkston
Elm Springs Colony
Clayton
Silver Lake
Freeman
OLIVET
Menno
Tripp
Kaylor

PACIFIC AND ST PAUL
CHICAGO MILWAUKEE ST PAUL AND PACIFIC

Twelvemile Creek
Jones Creek
Plum Creek
Wolf Creek
Coffee Creek
Pony Creek
River
Dry Creek
North Branch Dry Creek
South Branch Dry Creek
Lonetree Creek
Emanuel Creek
Dawson Creek
South Branch Dawson Creek
Furlong Creek
James River

SOIL ASSOCIATIONS

1 Ethan-Betts-Chaska association: Well drained to excessively drained, rolling to steep, loamy soils that formed in glacial till on uplands; and somewhat poorly drained and poorly drained, nearly level, silty and loamy soils on bottom land

2 Homme-Onita-Whitewood association: Well drained to somewhat poorly drained, nearly level to moderately sloping, silty soils that formed in glacial drift and alluvium on uplands

3 Egan-Wentworth association: Well drained, gently sloping and moderately sloping, silty soils that formed in glacial drift on uplands

4 Prosper-Clarno-Stickney association: Moderately well drained and well drained, nearly level to undulating, loamy and silty soils that formed in alluvium and glacial till on uplands

5 Clarno-Tetonka-Prosper association: Well drained, poorly drained, and moderately well drained, level to undulating, loamy and silty soils that formed in glacial till and alluvium on uplands

6 Clarno-Ethan-Tetonka association: Well drained and poorly drained, level to rolling, loamy and silty soils that formed in glacial till and alluvium on uplands

7 Hand-Clarno-Davison association: Well drained and moderately well drained, nearly level to gently rolling, loamy soils that formed in glacial melt-water deposits and glacial till on uplands

8 Crossplain-Clarno-Tetonka association: Poorly drained and well drained, nearly level and level, loamy and silty soils that formed in glacial till and alluvium on uplands

Compiled 1977

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

HUTCHINSON COUNTY, SOUTH DAKOTA

Scale 1:190,080

1 0 1 2 3 4 Miles

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

INDEX TO MAP SHEETS

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA

Scale 1:253,440

1 0 1 2 3 4 Miles

N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SANBORN COUNTY · MINER COUNTY · HANSON COUNTY · HUTCHINSON COUNTY · DAVISON COUNTY · McCOOK COUNTY · DOUGLAS COUNTY · TURNER COUNTY · BON HOMME COUNTY · YANKTON COUNTY · CHARLES MIX COUNTY

97°50′ · 97°40′ · 98°00′ · 97°30′ · 43°50′ · 43°40′ · 43°30′ · 43°20′

T. 104 N. · T. 103 N. · T. 102 N. · T. 101 N. · T. 100 N. · T. 99 N. · T. 98 N. · T. 97 N.

R. 61 W. · R. 60 W. · R. 59 W. · R. 58 W. · R. 57 W. · R. 56 W.

Fulton · Farmer · ALEXANDRIA · Rosedale Colony · Rockport Colony · Emery · HUTCHINSON · Elm Springs Colony · Dimock · Clayton · Parkston · Freeman · OLIVET · Menno · Tripp · Kaylor

CHICAGO AND NORTH WESTERN · CHICAGO MILWAUKEE ST PAUL AND PACIFIC

Inset, sheet 41 · Inset, sheet 58 · Inset, sheet 75 · Inset, sheet 92

SOIL LEGEND

The first capital letter is the initial letter of the soil name. The lower case letter that follows separates mapping units having names that begin with the same letter, except that it does not separate sloping or eroded phases. The second capital letter shows the slope class. Symbols without a slope letter are mostly for nearly level soils, but some are for miscellaneous land types that have a wide range of slope. A final number 2 in the symbol indicates that the soil is eroded.

SYMBOL	NAME
BeE	Betts and Ethan loams, 15 to 40 percent slopes
Bo	Bon loam
Ca	Chaska soils
Cb	Chaska soils, channeled
Cc	Clamo silty clay loam
CdA	Clarno loam, 0 to 3 percent slopes
CdB	Clarno loam, 3 to 6 percent slopes
CeA	Clarno-Davison loams, 0 to 2 percent slopes
CeB	Clarno-Davison loams, 2 to 4 percent slopes
CnC	Clarno-Ethan loams, 6 to 9 percent slopes
CsA	Clarno-Stickney loams, 0 to 2 percent slopes
Ct	Crossplain-Harps complex
DaB	Davis loam, 2 to 6 percent slopes
DaC	Davis loam, 6 to 9 percent slopes
DbA	Davison soils, 0 to 3 percent slopes
DcB	Davison-Onita complex, 2 to 6 percent slopes
DeA	Delmont loam, 0 to 3 percent slopes
DeB	Delmont loam, 3 to 6 percent slopes
DmB	Delmont-Rock outcrop complex, 2 to 9 percent slopes
DnD	Delmont-Talmo complex, 6 to 12 percent slopes
Do	Dimo loam
DsA	Dudley-Stickney complex, 0 to 2 percent slopes
Du	Durrstein silt loam
EaC	Egan silt loam, 6 to 9 percent slopes
EbC2	Egan-Betts complex, 3 to 9 percent slopes, eroded
EgB	Egan and Wentworth silt loams, 2 to 6 percent slopes
EnA	Enet loam, 0 to 2 percent slopes
EtB	Ethan-Betts loams, 3 to 6 percent slopes
EtC2	Ethan-Betts loams, 6 to 9 percent slopes, eroded
EtD	Ethan-Betts loams, 9 to 15 percent slopes
EuB	Ethan-Clarno loams, 2 to 6 percent slopes
EuC	Ethan-Clarno loams, 6 to 9 percent slopes
EwC	Ethan-Homme complex, 6 to 9 percent slopes
Fa	Fedora soils
HaA	Hand loam, 0 to 3 percent slopes
HaB	Hand loam, 3 to 6 percent slopes
HaC	Hand loam, 6 to 9 percent slopes
HbC	Hand-Betts loams, 6 to 9 percent slopes
HcA	Hand-Bonilla loams, 0 to 3 percent slopes
HdB	Hand-Davison loams, 3 to 6 percent slopes
HmA	Henkin fine sandy loam, 0 to 2 percent slopes
HmB	Henkin fine sandy loam, 2 to 6 percent slopes
HnB	Henkin variant fine sandy loam, 0 to 6 percent slopes
HoC	Homme-Ethan complex, 6 to 9 percent slopes
HtA	Homme-Onita complex, 0 to 2 percent slopes
HtB	Homme-Onita complex, 2 to 6 percent slopes
Ja	James silty clay
La	Lamo silty clay loam
Lm	Lamo-Wann complex, frequently flooded
Ma	Marsh
OaA	Onita silt loam, 0 to 3 percent slopes
PcA	Prosper-Clarno loams, 0 to 2 percent slopes
Pr	Prosper-Stickney complex
Ps	Prosper and Crossplain soils
ReB	Redstoe silt loam, 0 to 6 percent slopes
Sa	Salmo silty clay loam
St	Storla variant loam
Te	Tetonka silty clay loam
Tt	Tetonka-Harps complex
Tw	Tetonka and Whitewood silty clay loams
Wa	Wann loam
Ww	Worthing silty clay loam

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water; w)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (CeA; FoB2)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

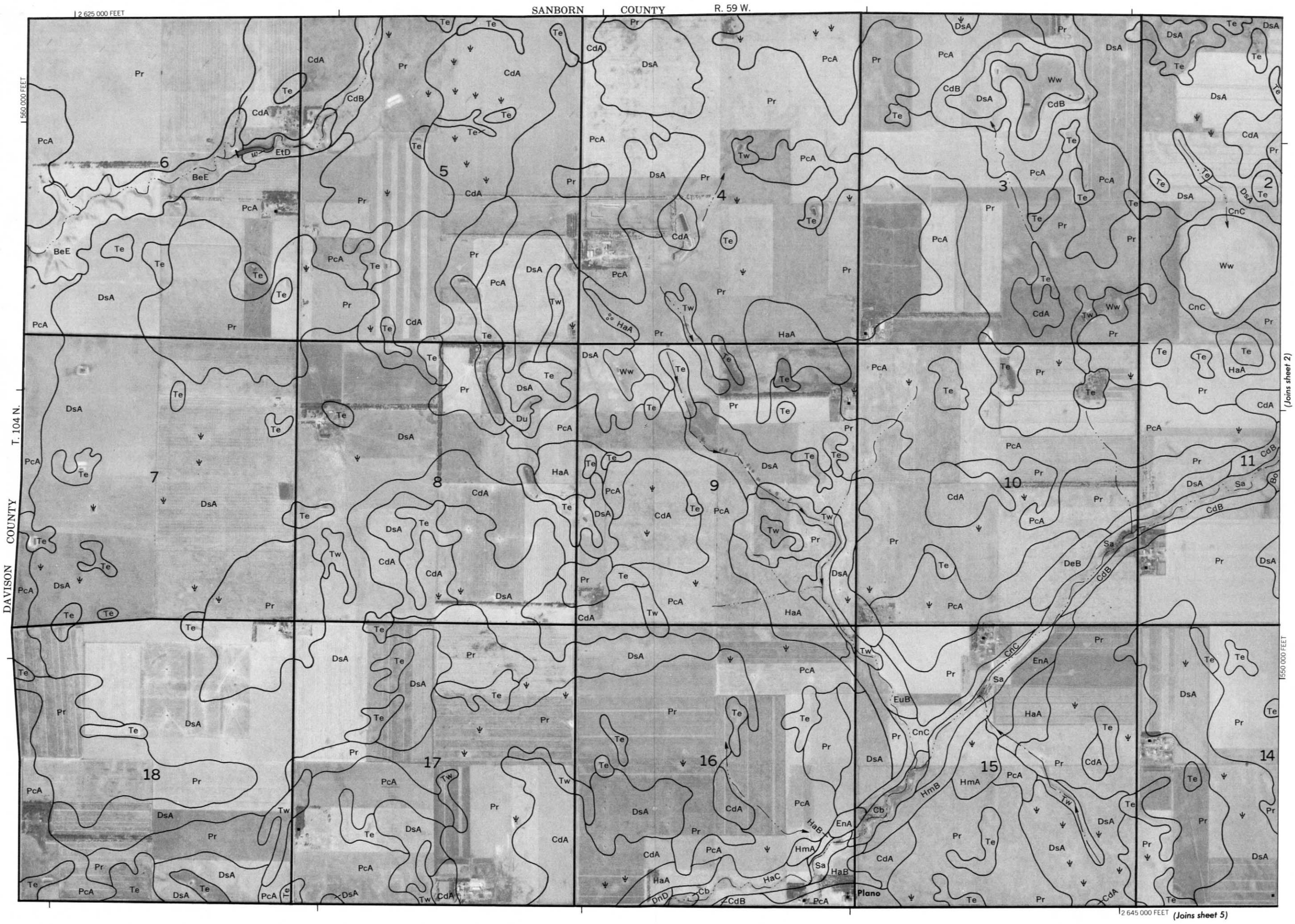
MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 1

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 1

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 2

SANBORN COUNTY | MINER COUNTY

R. 59 W. | R. 58 W.

2 670 000 FEET

560 000 FEET

T. 104 N.

(Joins sheet 1)

(Joins sheet 3)

(Joins sheet 6)

550 000 FEET

2 650 000 FEET

EVANGELICAL ASSOCIATION OF FAIRVIEW TOWNSHIP CEMETERY

Rock Creek

Scale · 1:20000

1 Mile

5000 Feet

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 2

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 3

MINER COUNTY

R. 58 W. | R. 57 W.

2 675 000 FEET

560 000 FEET

T. 104 N.

(Joins sheet 2)

2 690 000 FEET

550 000 FEET

(Joins sheet 7)

(Joins sheet 4)

N

1 Mile

5000 Feet

Scale 1:20000

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 3

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 4

4

N

MINER COUNTY

R. 57 W.

2 715 000 FEET

560 000 FEET

T. 104 N.

McCOOK COUNTY

1 Mile

5000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

1 550 000 FEET

(Joins sheet 3)

(Joins sheet 8)

2 700 000 FEET

Epiphany

SPRING LAKE

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 4

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 5

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 5

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 625 000 FEET

545 000 FEET

R. 59 W.

(Joins sheet 1)

T. 104 N.

COUNTY

DAVISON

ROCK CREEK CEMETERY

Rock Creek

(Joins sheet 6)

(Joins sheet 9)

2 645 000 FEET

530 000 FEET

5

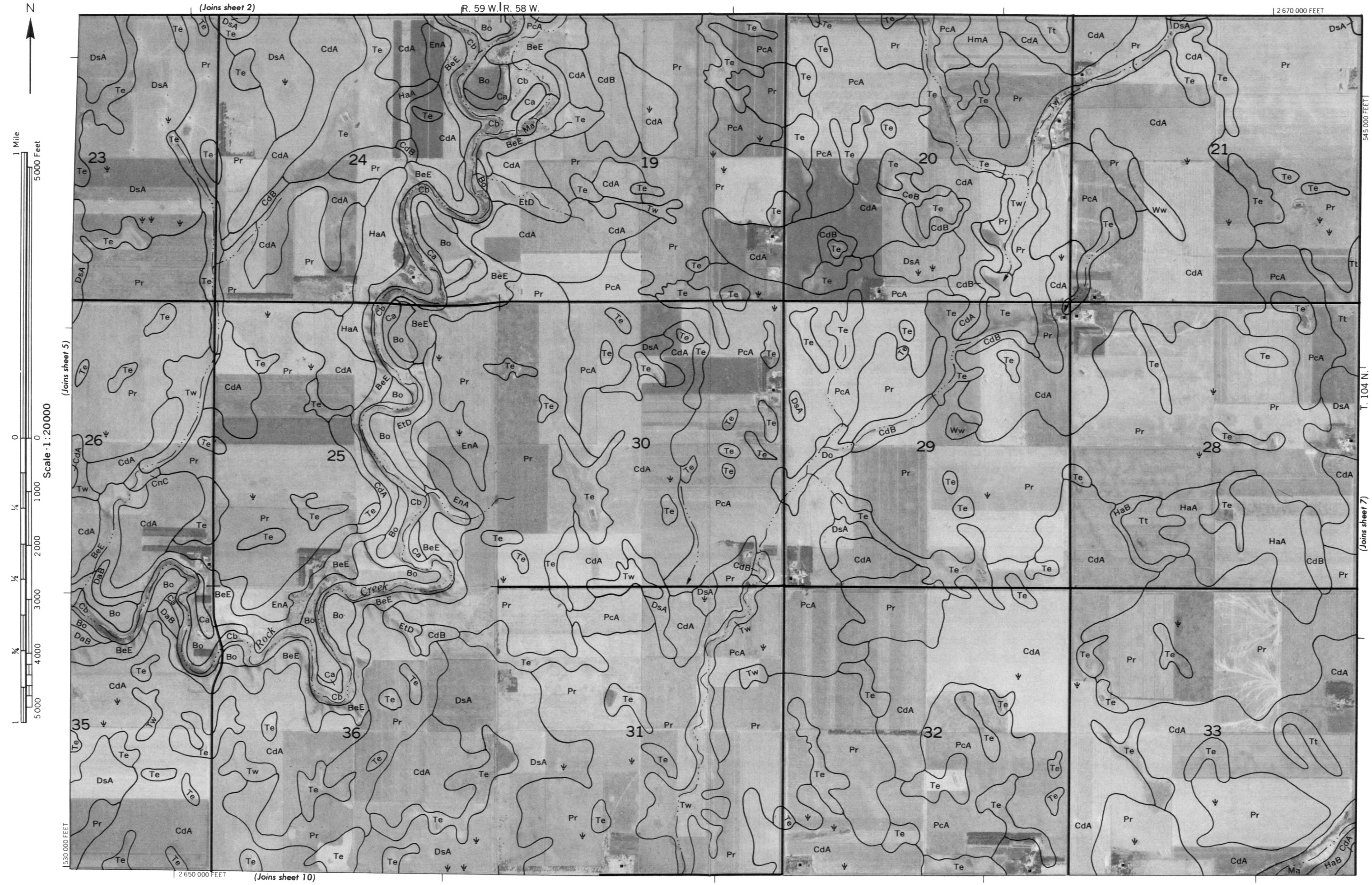
N

1 Mile

5000 Feet

Scale 1:20000

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 6



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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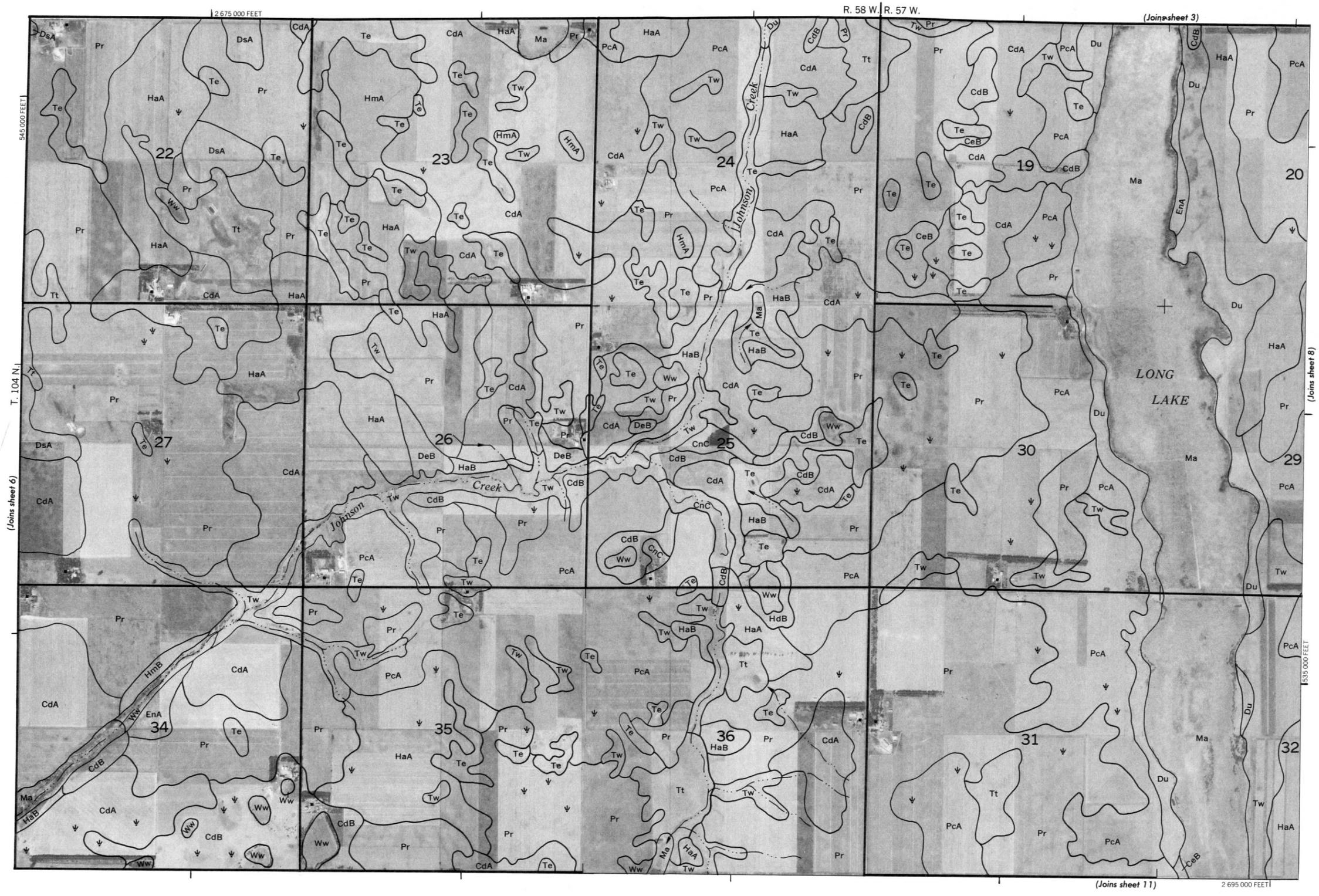

(8)

N

R. 57 W.

(Joins sheet 4)

(Joins sheet 7)

(Joins sheet 12)

2 715 000 FEET

2 700 000 FEET

535 000 FEET

545 000 FEET

T. 104 N.

McCOOK COUNTY

1 Mile

5 000 Feet

Scale 1:20000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

1½ 5 000

20 21 22 23 24

29 28 27 26 25

32 33 34 35 36

PcA Pr Tt Te Tw HaA CdA DsA Ma CeB CdB CnC Ww Du HmB HaB

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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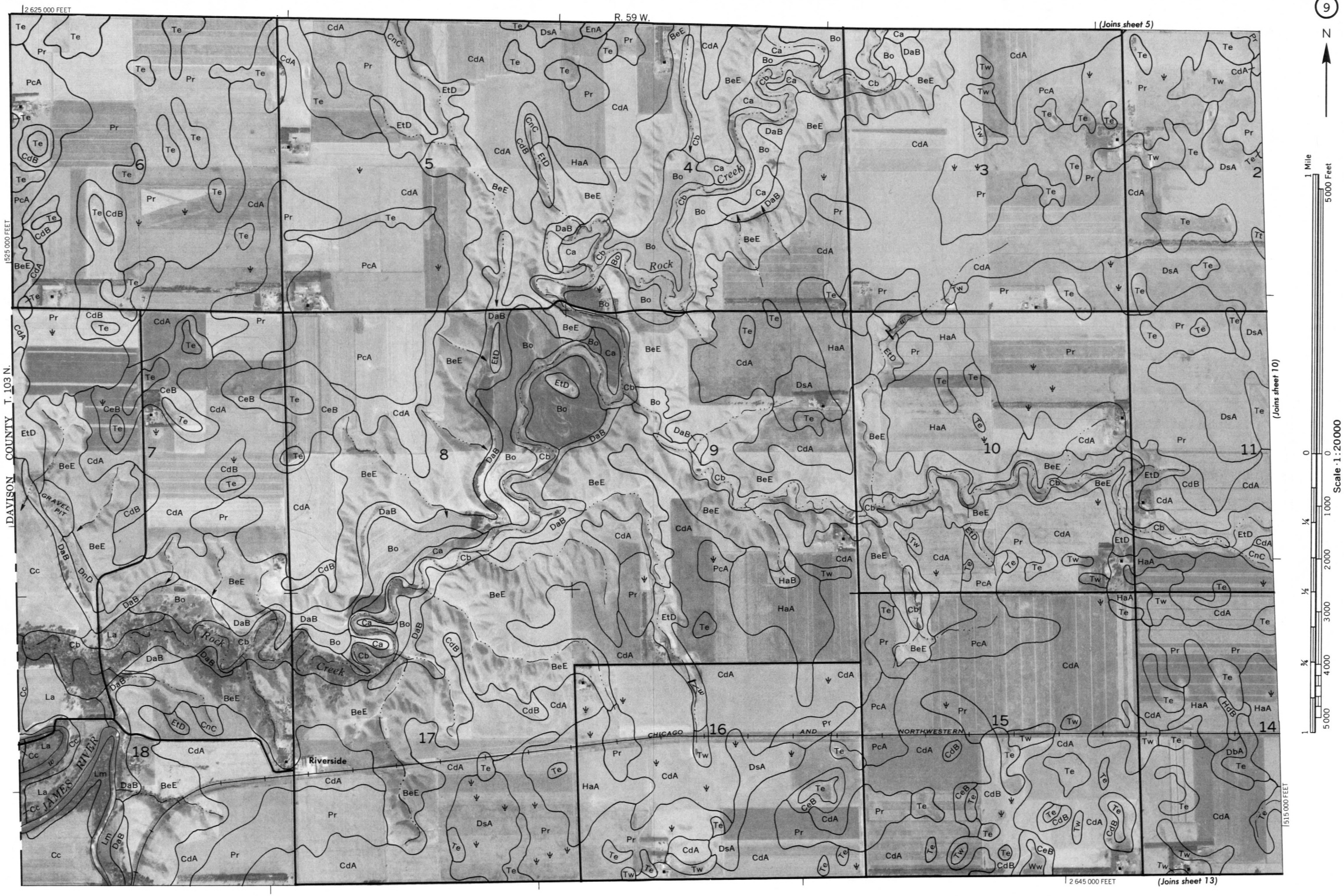
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 8



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 9

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

10

N

1 Mile 5000 Feet

Scale 1:20000

(Joins sheet 6)

R. 59 W. | R. 58 W.

2 670 000 FEET

530 000 FEET

T. 103 N.

(Joins sheet 9)

(Joins sheet 11)

515 000 FEET

2 650 000 FEET

(Joins sheet 14)

Johnson Creek

GRAVEL PIT

CHICAGO AND NORTHWESTERN

Fulton

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 10

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 11

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

(Joins sheet 8)

R. 57 W.

2 715 000 FEET

530 000 FEET

(Joins sheet 11)

520 000 FEET

(Joins sheet 16) 2 700 000 FEET

T. 103 N.

McCOOK COUNTY

GRACELAND CEMETERY

LAKE SIDE CEMETERY

CHICAGO AND NORTH WESTERN

Farmer

Lake Eli

1 Mile

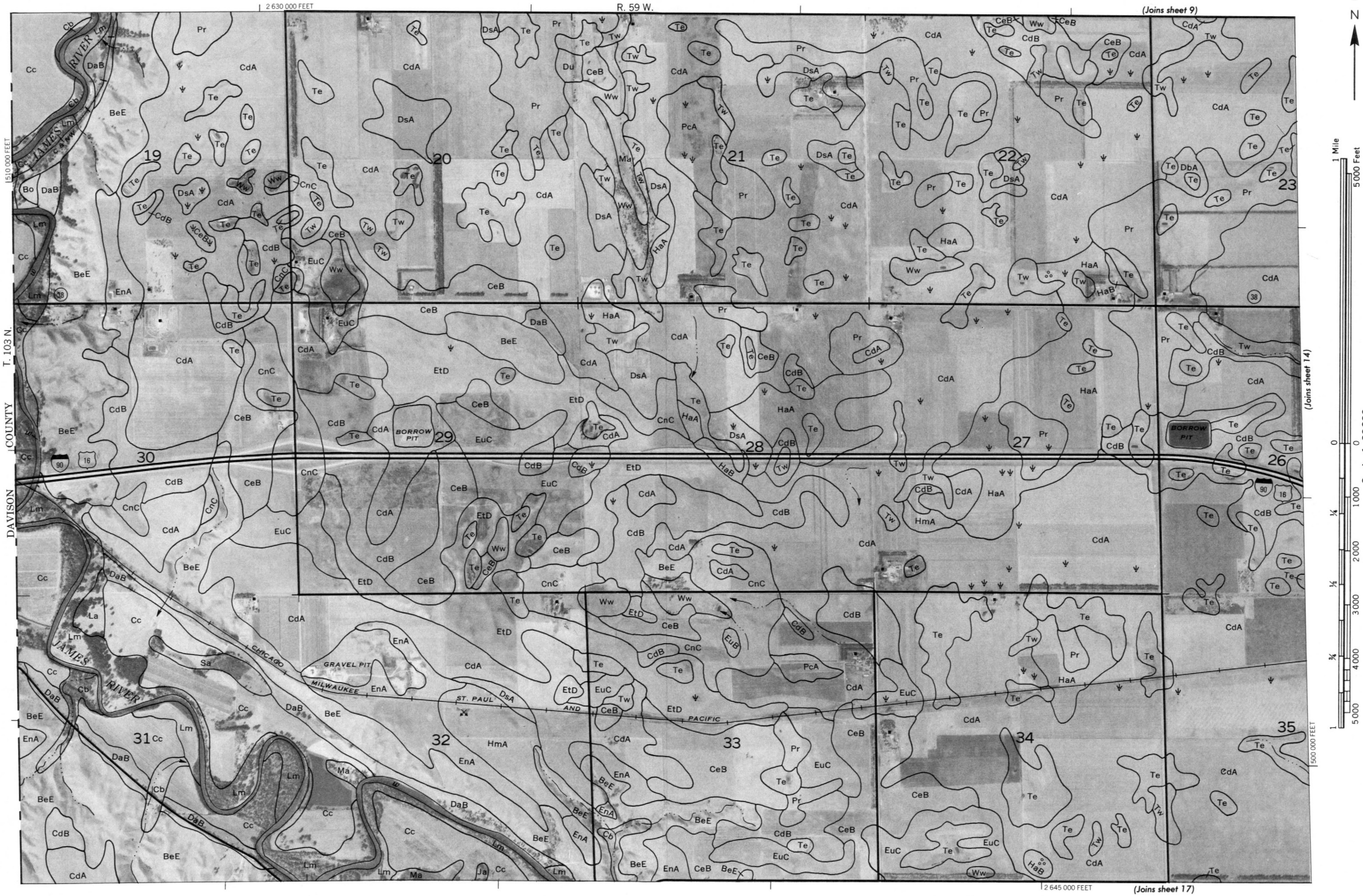
5000 Feet

Scale 1:20000

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 12

13



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 13

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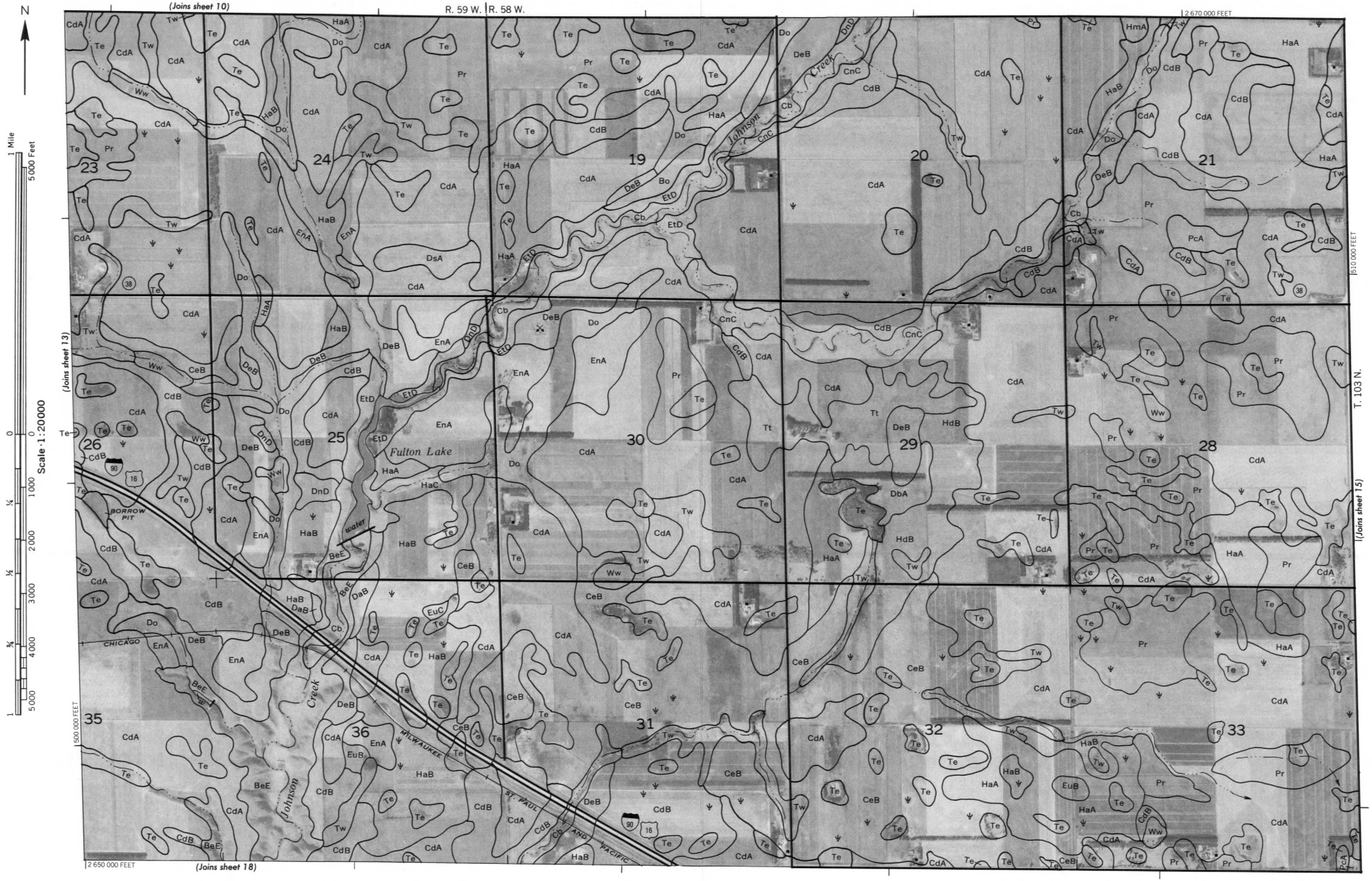
HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 14



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 15

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 675 000 FEET

R. 58 W. | R. 57 W.

(Joins sheet 11)

15

N

1 Mile

5000 Feet

Scale 1:20000

T. 103 N.

5 510 000 FEET

(Joins sheet 14)

(Joins sheet 16)

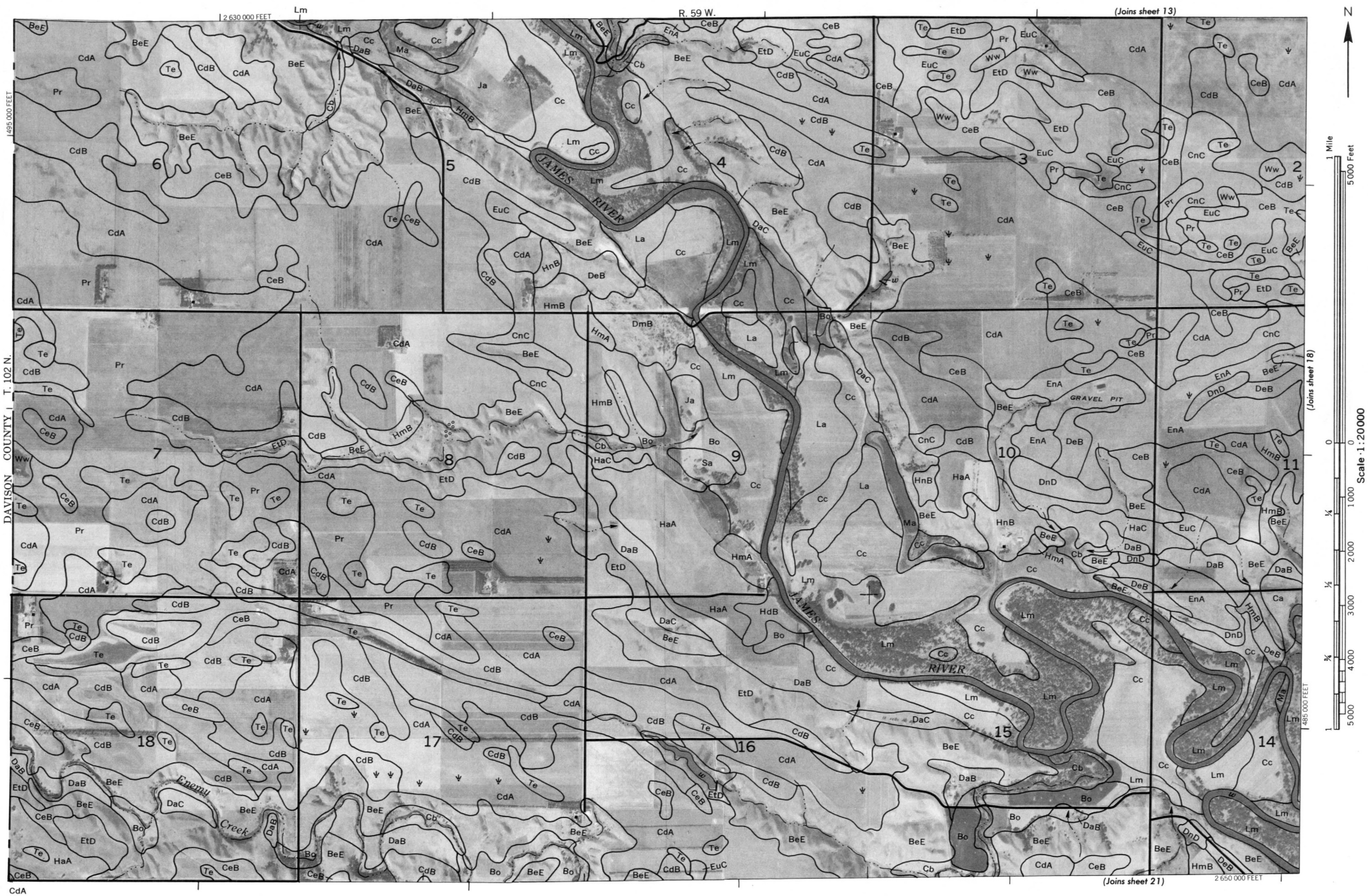
5 500 000 FEET

(Joins sheet 19)

2 695 000 FEET

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 16

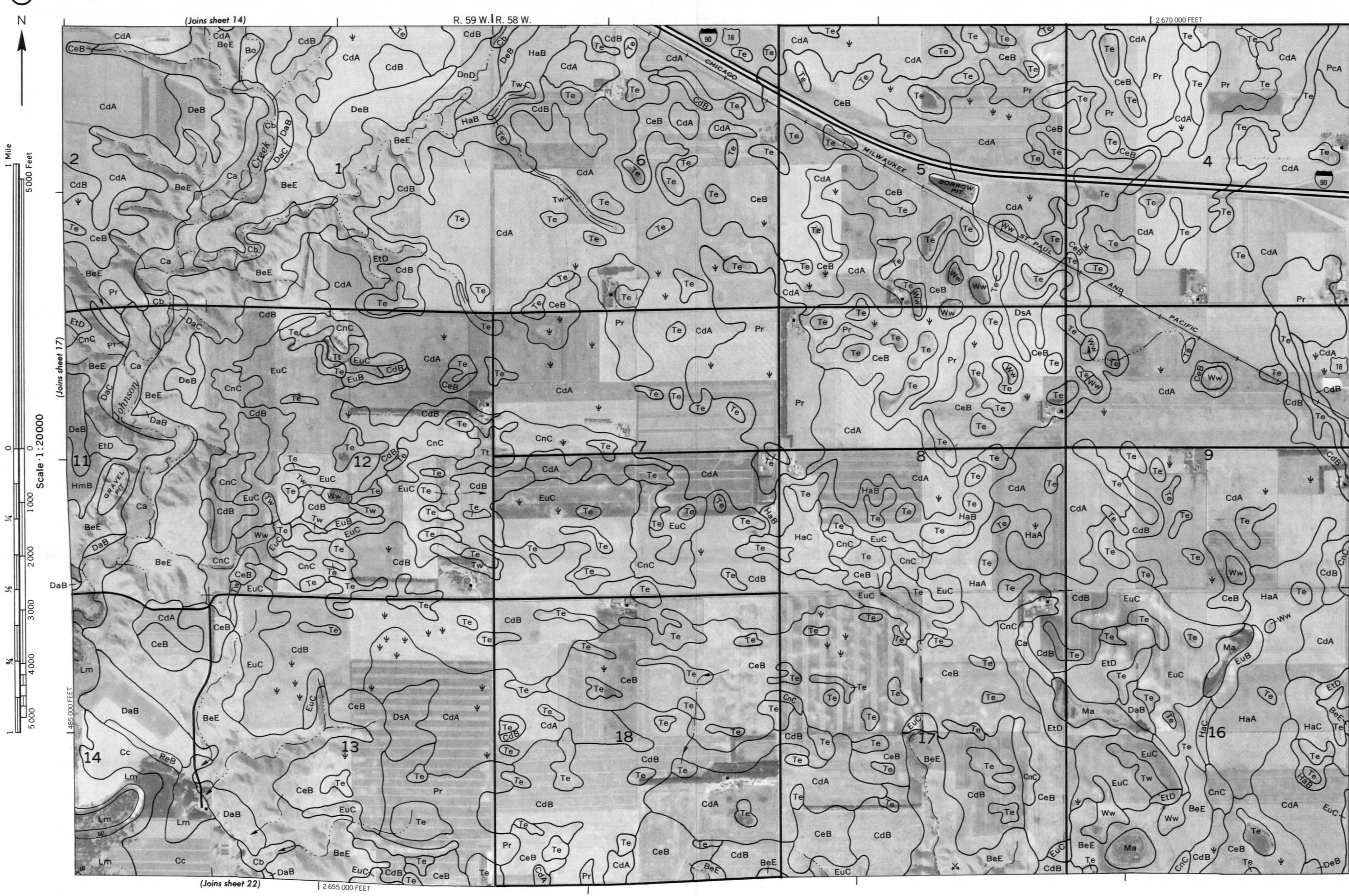
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 17

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 18



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HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 19

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

R. 58 W. | R. 57 W.

2 675 000 FEET

495 000 FEET

T. 102 N.

(Joins sheet 15)

(Joins sheet 18)

(Joins sheet 20)

(Joins sheet 23)

2 695 000 FEET

485 000 FEET

ALEXANDRIA
(county seat)

BORROW PIT

BORROW PIT

County Fair Grounds

Sewage Disposal Area

DmB QUARRY

Pierre Creek

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC

Scale 1:20000

1 Mile

5000 Feet

20

N

(Joins sheet 16)

R. 57 W.

2 720 000 FEET

500 000 FEET

T. 102 N.

McCOOK COUNTY

(Joins sheet 19)

485 000 FEET

2 700 000 FEET (Joins sheet 24)

1 Mile

5 000 Feet

Scale 1 : 20000

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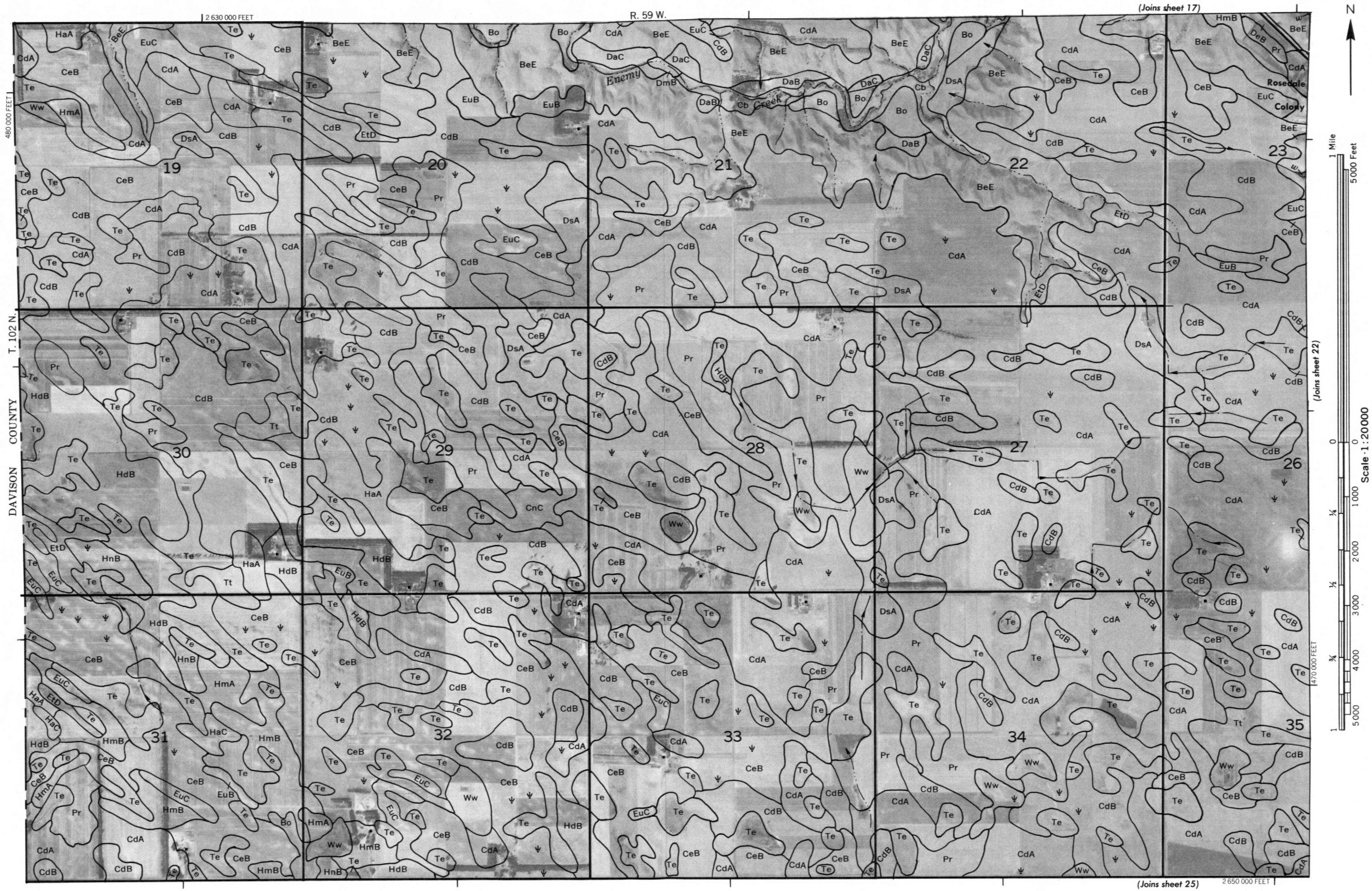
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 20



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 21

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N

(Joins sheet 18)

R. 59 W. | R. 58 W.

2 670 000 FEET

1 Mile

5 000 Feet

Scale · 1 : 20000

(Joins sheet 21)

470 000 FEET

480 000 FEET

T. 102 N.

(Joins sheet 23)

(Joins sheet 26)

2 655 000 FEET

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 22

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 23

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

R. 58 W. | R. 57 W.

2 675 000 FEET

480 000 FEET

T. 102 N.

(Joins sheet 22)

(Joins sheet 19)

(Joins sheet 24)

2 695 000 FEET (Joins sheet 27)

470 000 FEET

Pierre Creek

C. M. St. P. & P.

22 23 24 19 20 27 26 25 30 29 34 35 36 31 32

N

1 Mile

5000 Feet

Scale 1:20000

24

N

(Joins sheet 20)

R. 57 W.

2 720 000 FEET

1 Mile 5 000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

20 21 22 23 24

29 28 27 26 25

32 33 34 35 36

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC

Wolf Creek

Plum Creek

ST. MARTIN'S CEMETERY

Sewage Disposal Area

Emery

(Joins sheet 23)

(Joins sheet 28)

480 000 FEET

470 000 FEET

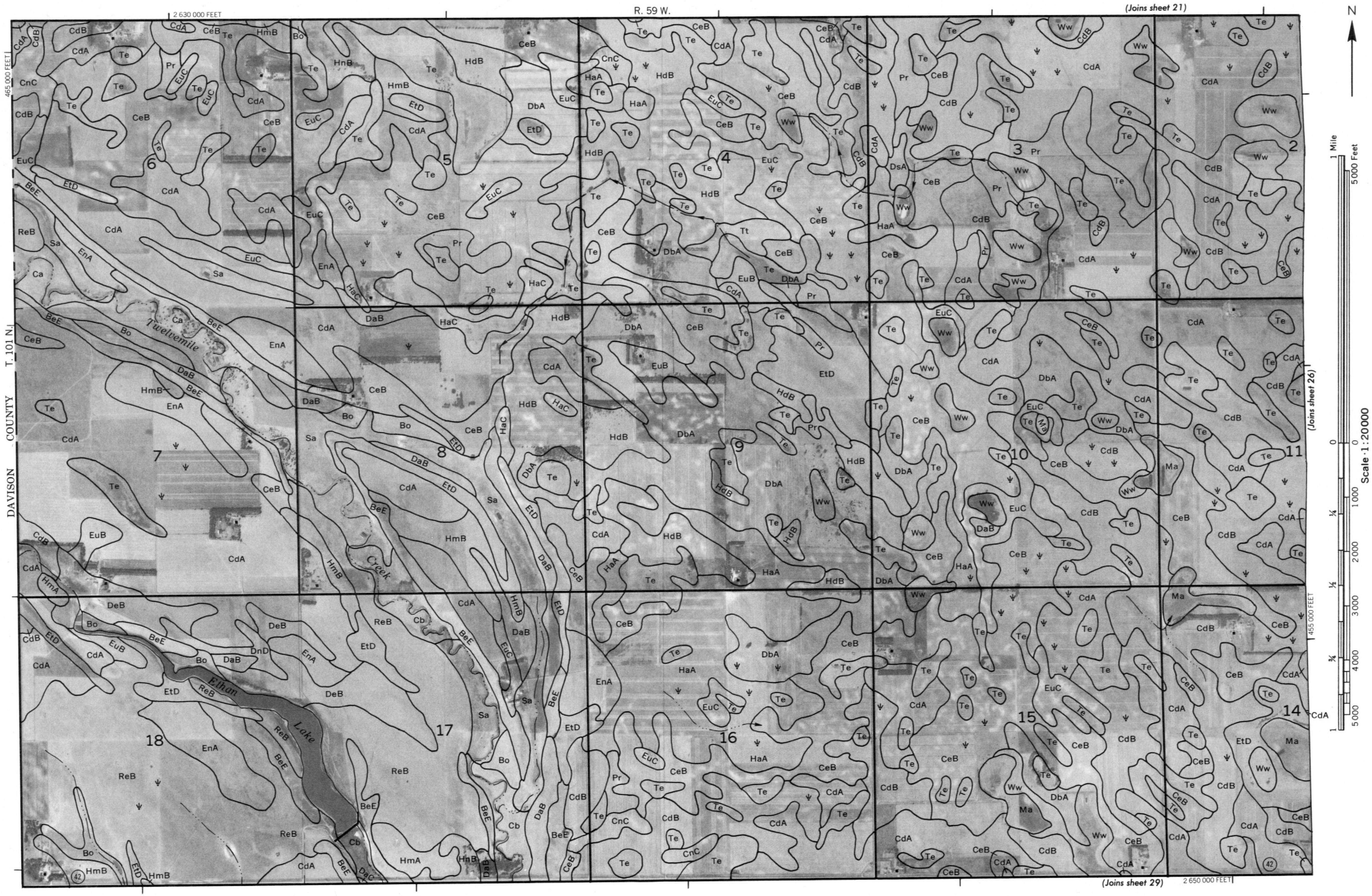
2 700 000 FEET

T. 102 N.

McCOOK COUNTY

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 24

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

26

N

1 Mile 5,000 Feet

0 0

Scale 1:20000

1/4 1/2 3/4 1

1 000 2000 3000 4000 5000

(Joins sheet 22) R. 59 W. | R. 58 W. 2 670 000 FEET

455 000 FEET

T. 101 N.

(Joins sheet 25)

(Joins sheet 27)

(Joins sheet 30) 2 655 000 FEET

Rockport Colony

JAMES RIVER

JAMES RIVER

Crawford Pit

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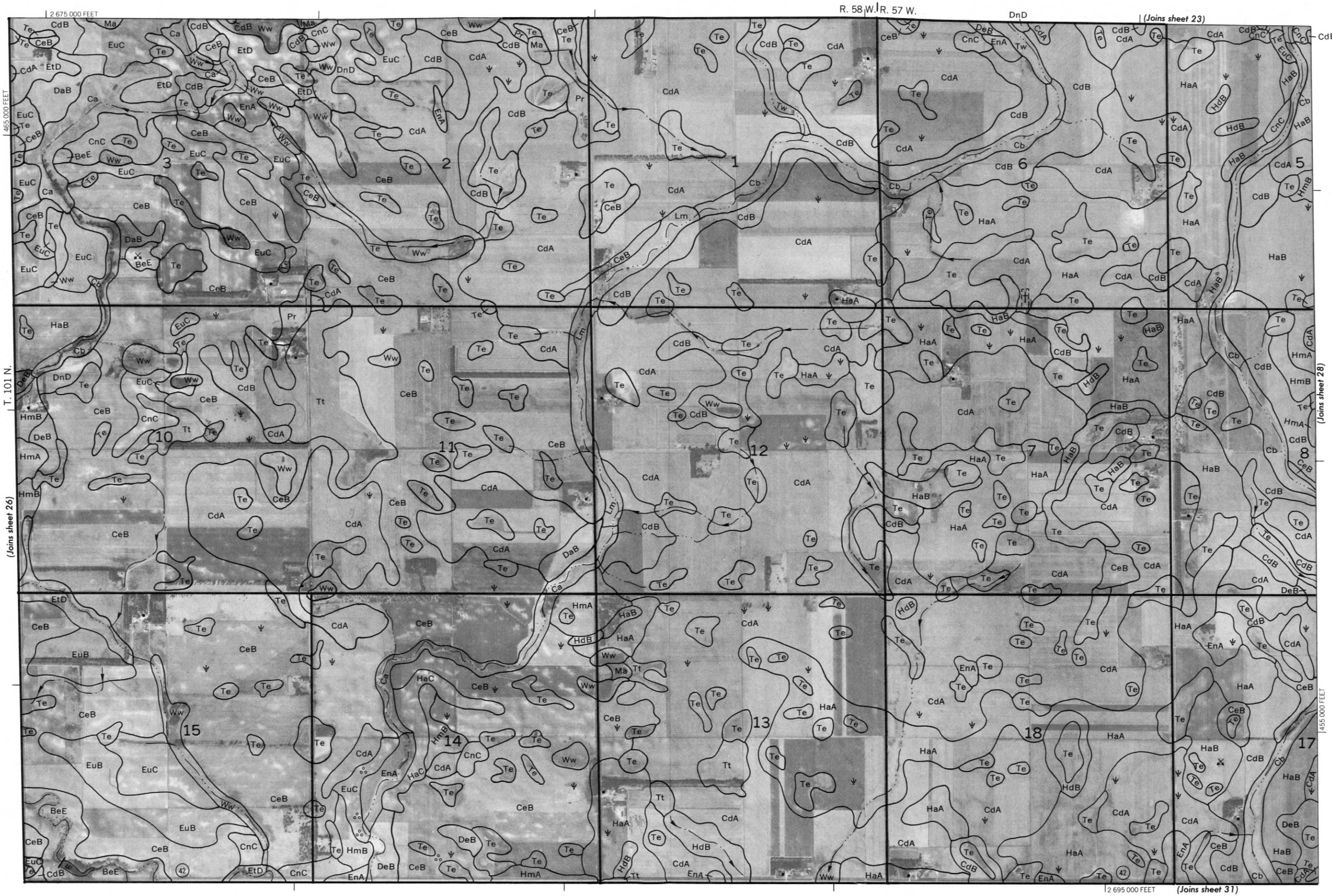
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

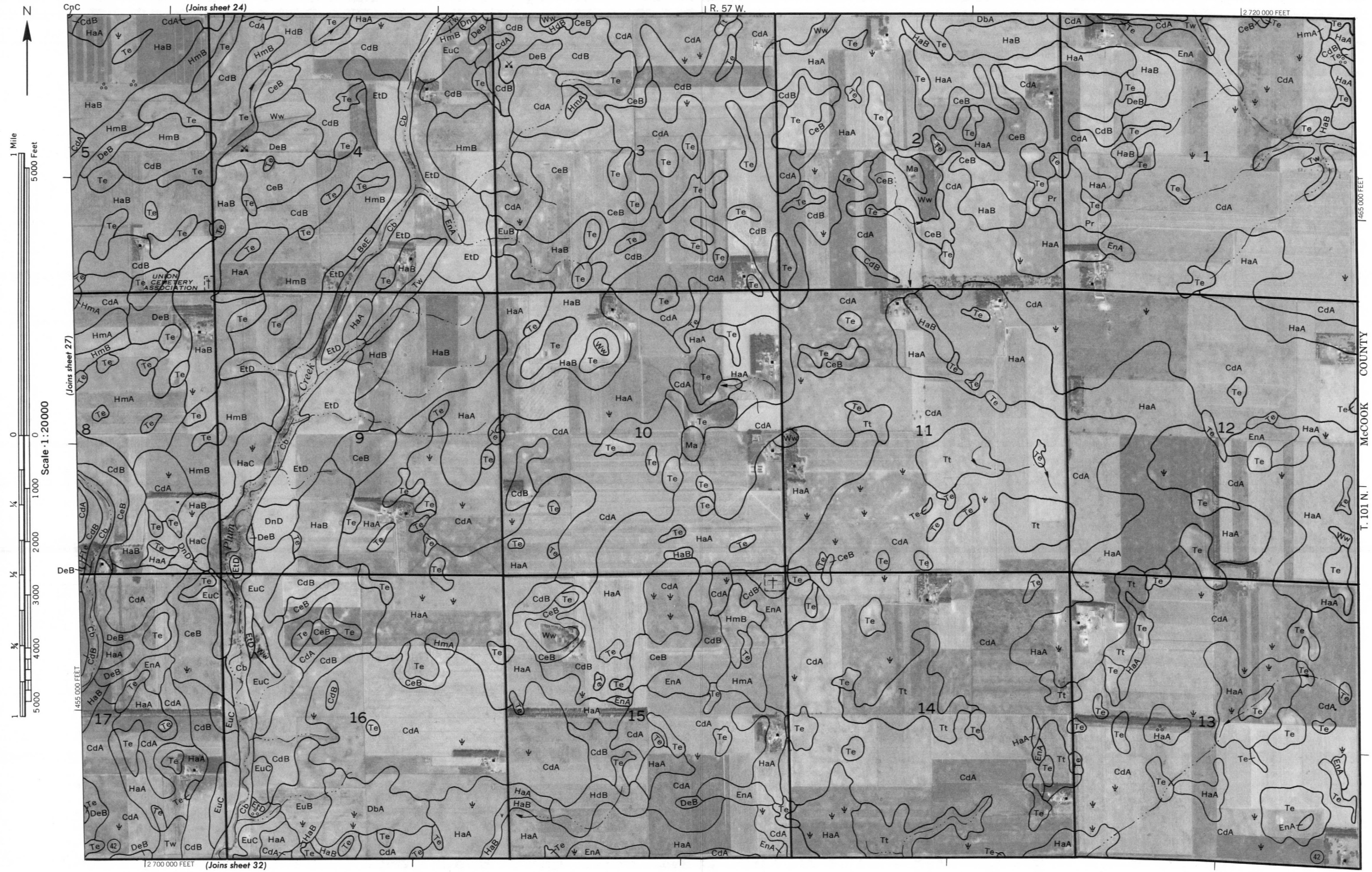
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 26



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 27

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 28



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 28

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 29

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

29

N

2 630 000 FEET

R. 59 W.

(Joins sheet 25)

445 000 FEET

T. 101 N.

DAVISON COUNTY

HUTCHINSON COUNTY

435 000 FEET

2 650 000 FEET

(Joins sheet 35)

(Joins 36)

(Joins sheet 30)

1 Mile

5000 Feet

Scale 1:20000

N

(Joins sheet 26)

R. 59 W. | R. 58 W.

2 675 000 FEET

450 000 FEET

T. 101 N.

1 Mile

5000 Feet

Scale 1:20000

(Joins sheet 29)

1 435 000 FEET

2 655 000 FEET

(Joins sheet 36)

HUTCHINSON COUNTY

(Joins sheet 31)

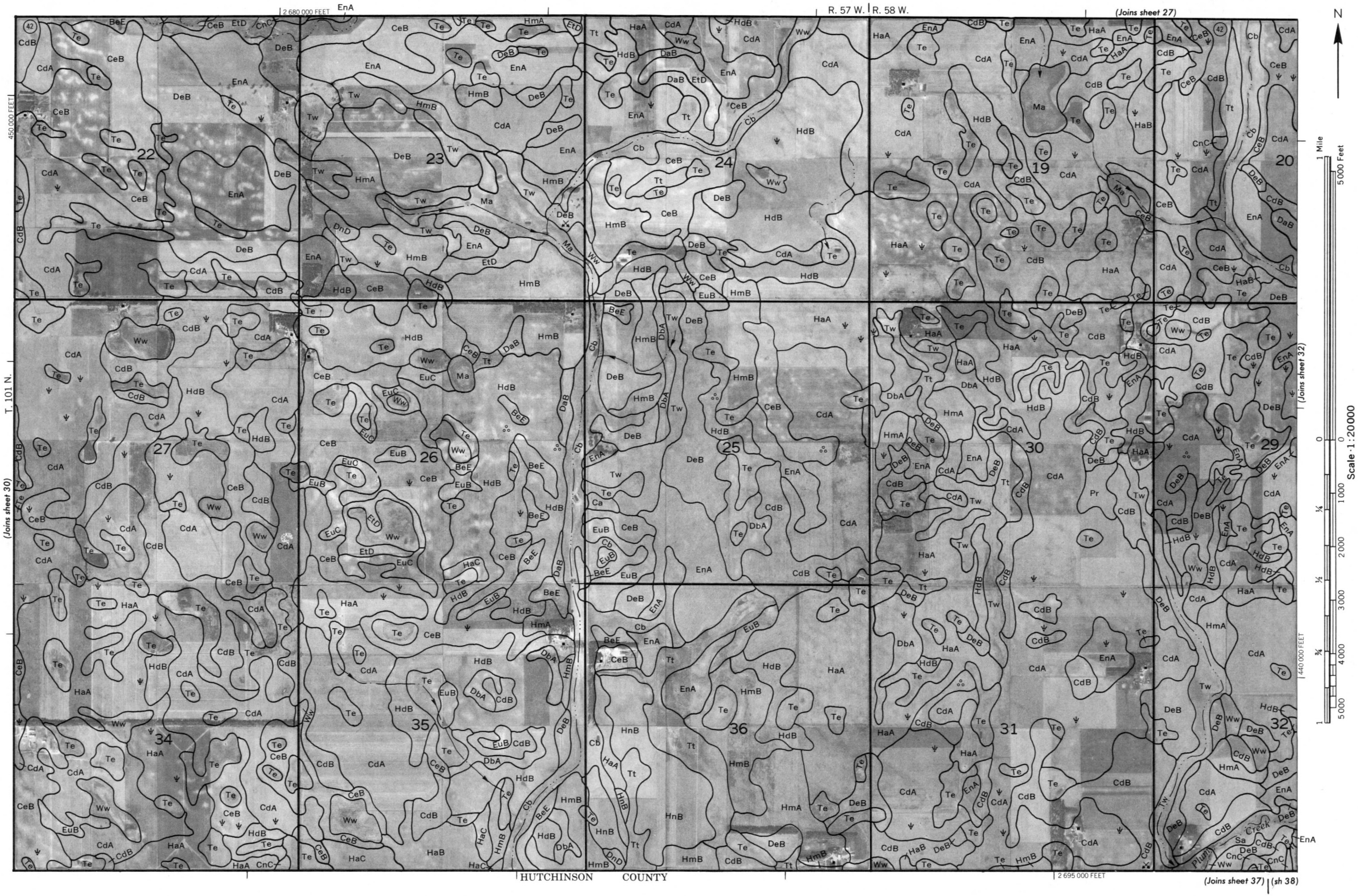
(Joins sheet 36) | (sh 37)

JAMES RIVER

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 30

31



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 31

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

(Joins sheet 28)

R. 57 W.

2 720 000 FEET

450 000 FEET

T. 101 N.

McCOOK COUNTY

1 Mile

5000 Feet

Scale · 1:20000

(Joins sheet 31)

440 000 FEET

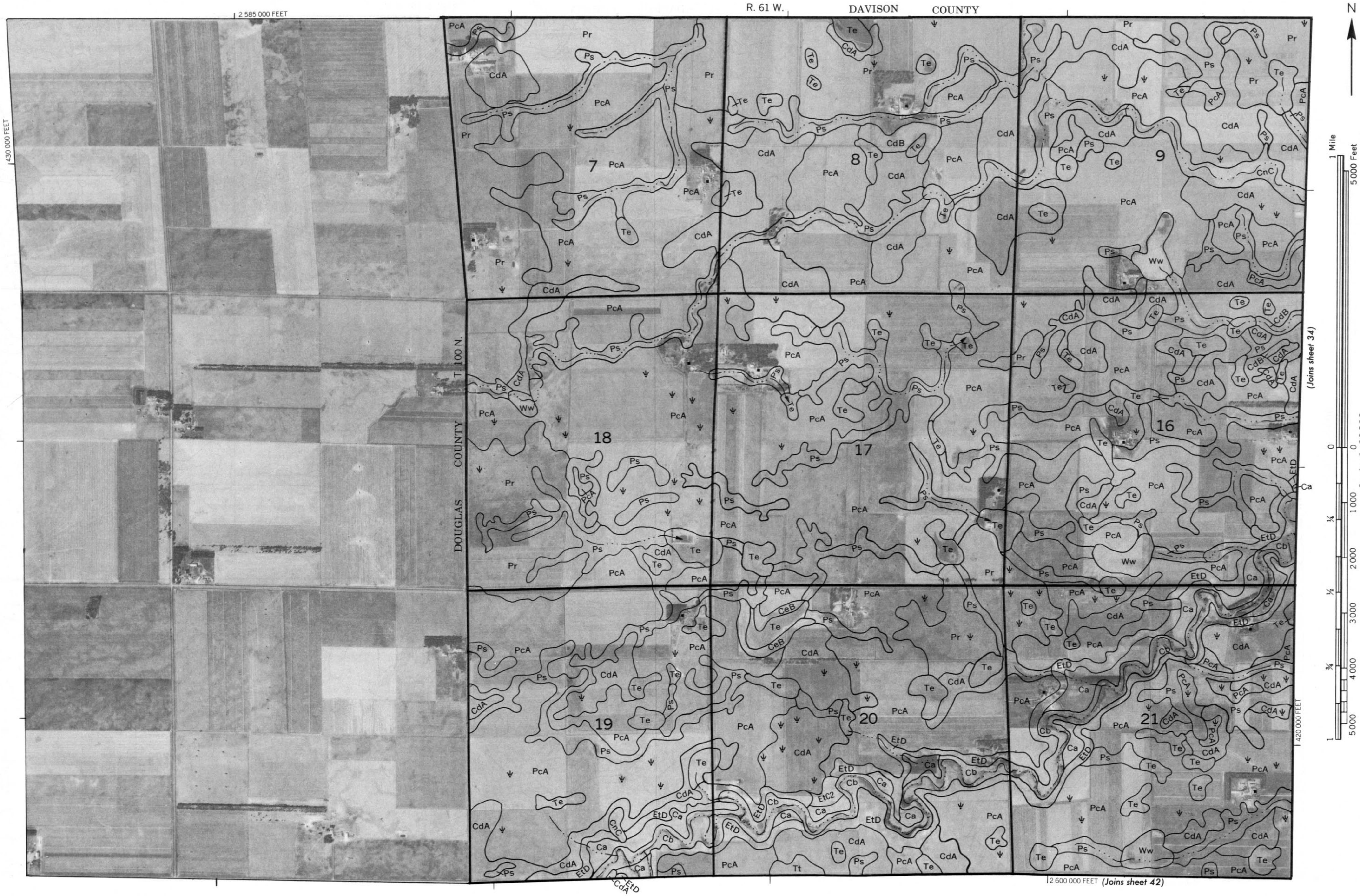
2 700 000 FEET

HUTCHINSON COUNTY

(Joins sheet 38) | (sh 39)

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 32



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 33

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

34

N

DAVISON COUNTY

R. 61 W. | R. 60 W.

2 625 000 FEET

430 000 FEET

420 000 FEET

2 605 000 FEET

T. 100 N.

1 Mile 5000 Feet

Scale · 1 : 20000

0 0 ¼ 1000 ½ 2000 ¾ 4000 1 5000

(Joins sheet 33)

(Joins sheet 43)

(Joins sheet 35)

Dimock

Sts. Peter & Paul Church

South Fork

Turkey Creek

ST. PAUL

MILWAUKEE

CHICAGO

PACIFIC

AND

10 11 12 7 8

15 14 13 18 17

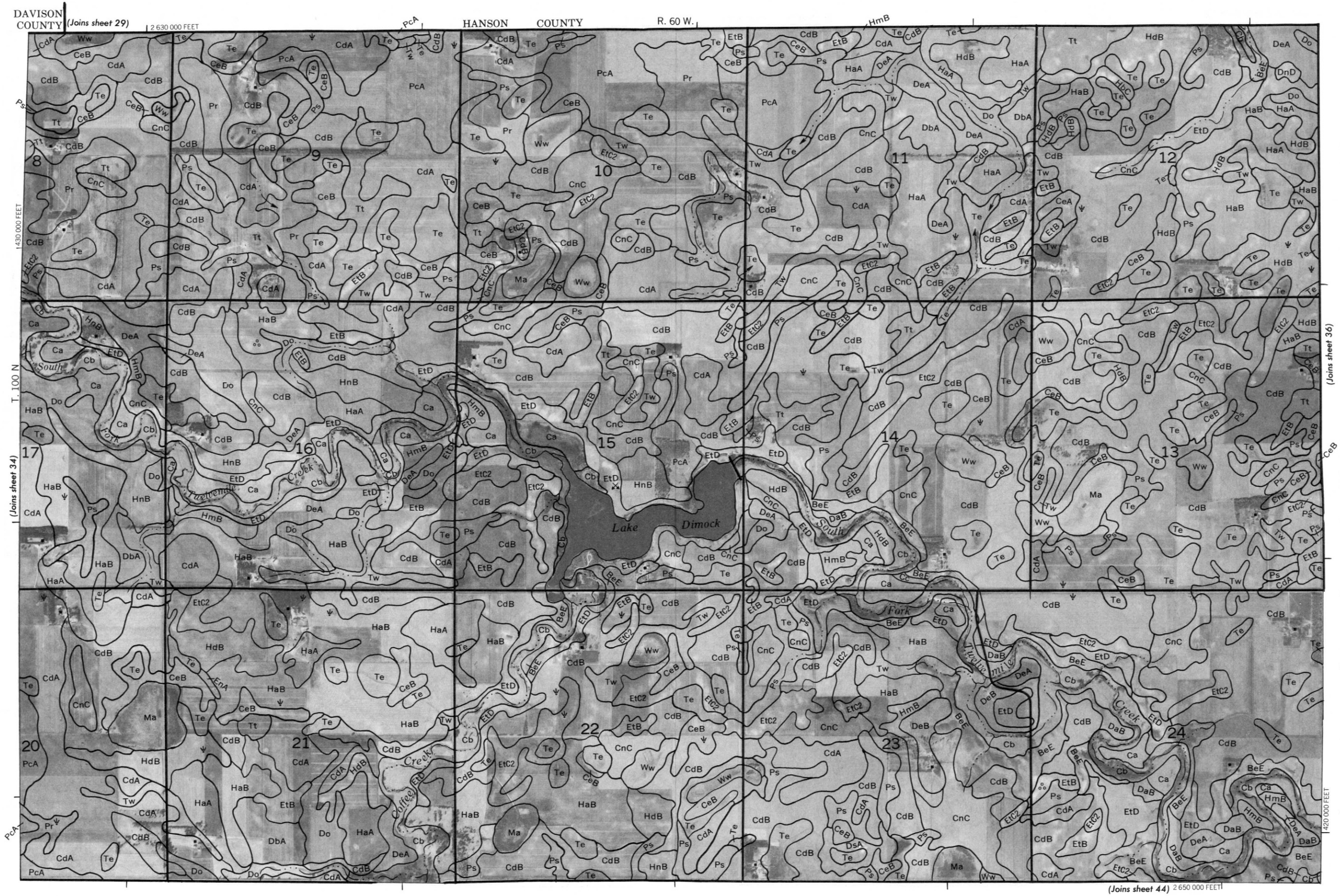
22 23 24 19 20

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 34

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 35

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



35

N

1 Mile
5000 Feet

Scale 1:20000

36

N

(Joins 29) (Joins sheet 30)

HANSON COUNTY

R. 59 W.

2 675 000 FEET

435 000 FEET

(Joins sheet 35)

Marcy Colony

RIVER

JAMES

T. 100 N.

(Joins sheet 37)

420 000 FEET

(Joins sheet 45) 2 655 000 FEET

1 Mile

5 000 Feet

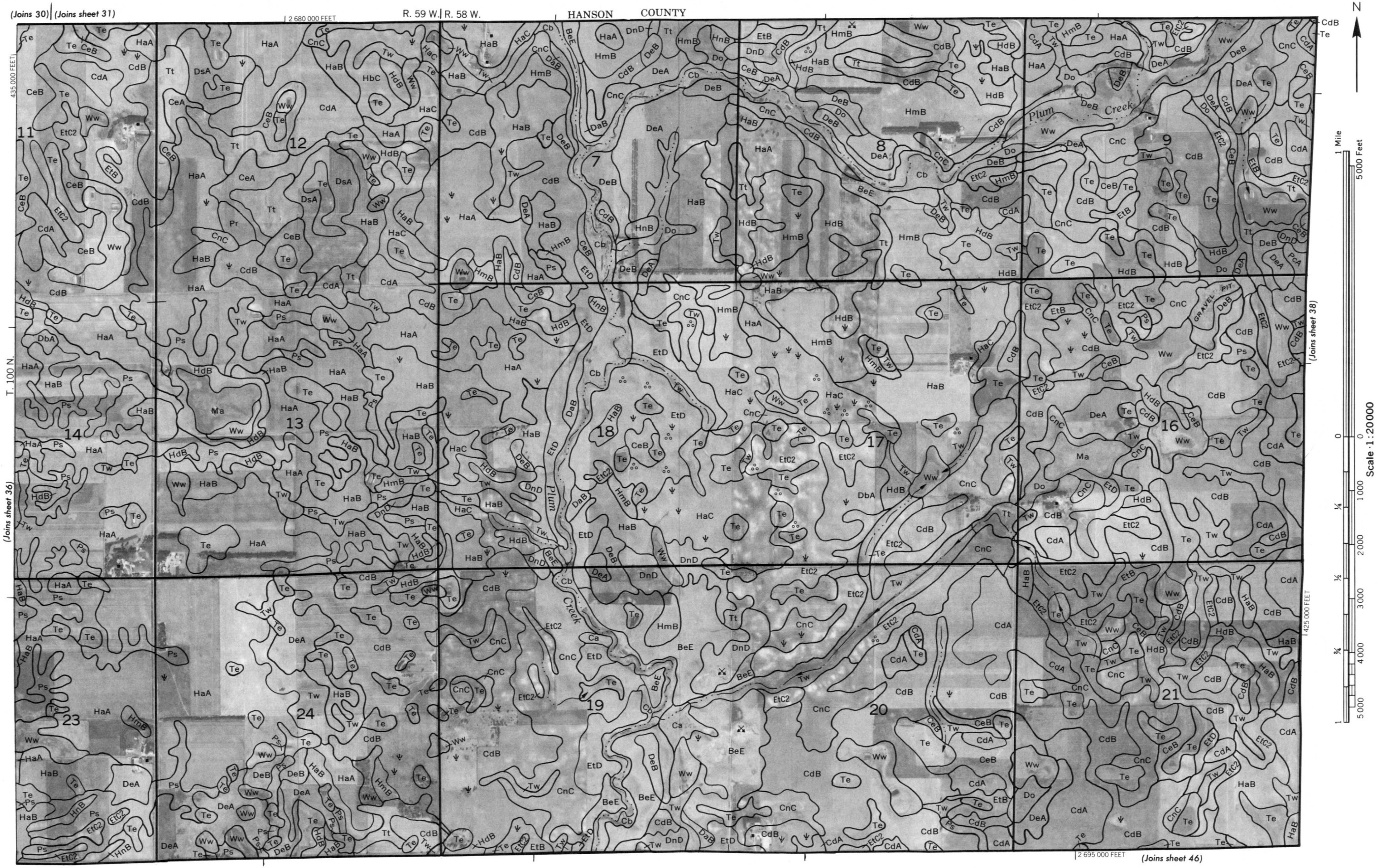
Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 36



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 37

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

38

N

1 Mile

5000 Feet

Scale · 1:20000

(Joins 31) (Joins sheet 32)

HANSON COUNTY

R. 58 W. R. 57 W.

2 720 000 FEET

435 000 FEET

T. 100 N.

(Joins sheet 37)

(Joins sheet 39)

1 425 000 FEET

2 700 000 FEET

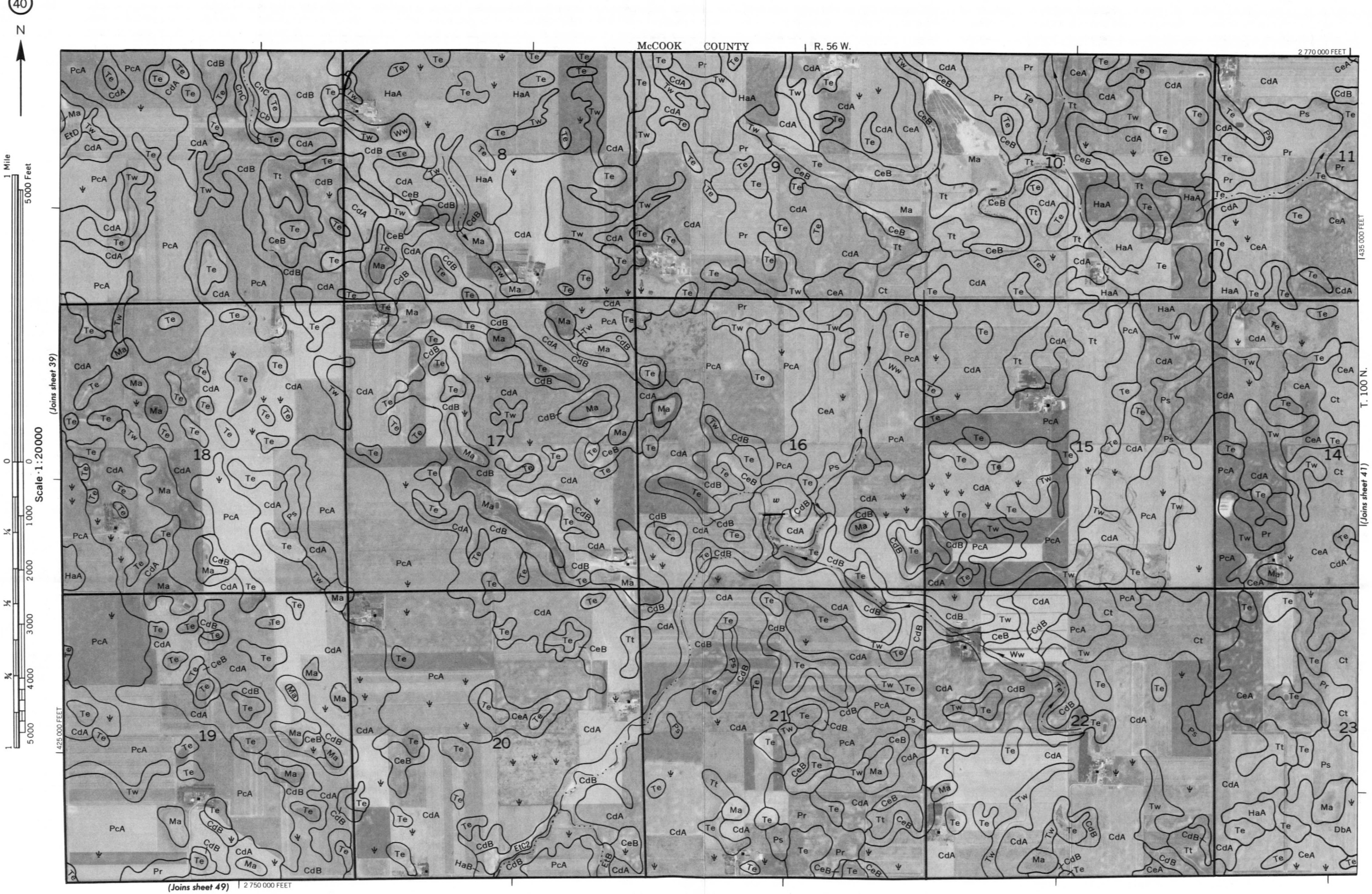
(Joins Sheet 47)

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

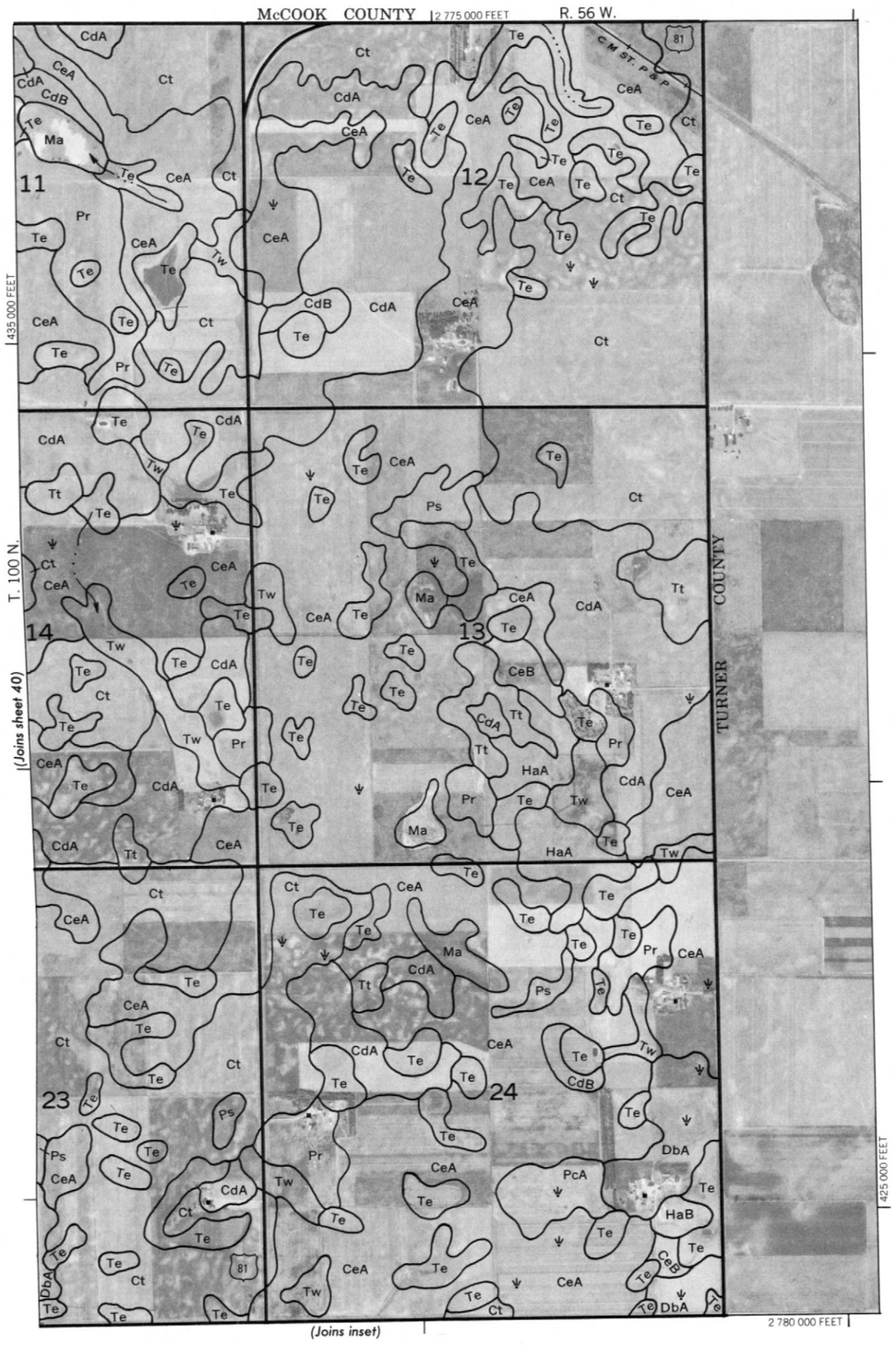
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 38

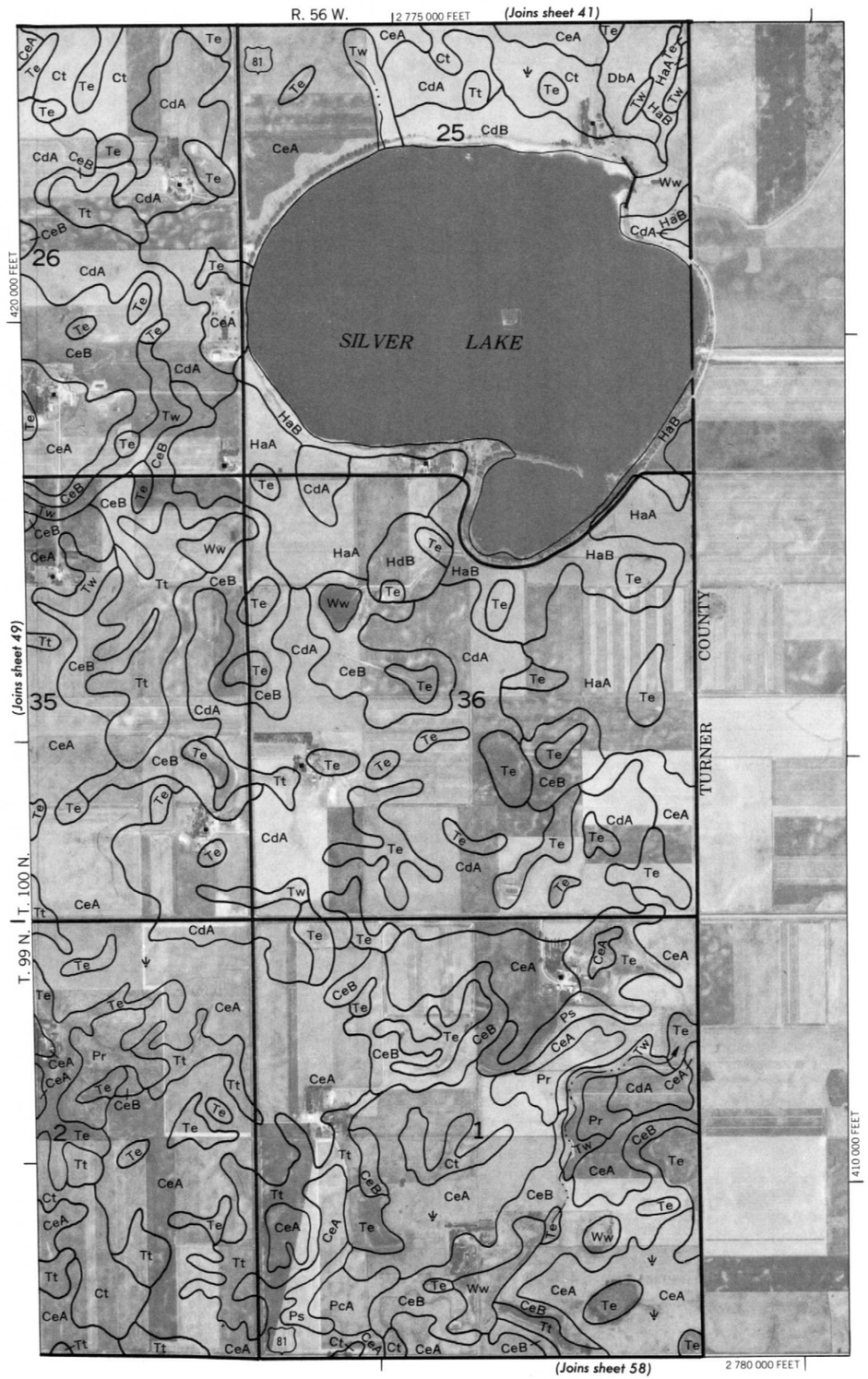
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 39

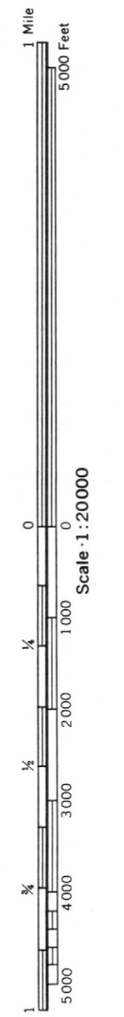
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.







HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 41

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

42

N

1 Mile 5000 Feet

Scale 1:20000

(Joins sheet 33)

R. 61 W.

2 600 000 FEET

415 000 FEET

405 000 FEET

2 585 000 FEET

(Joins sheet 50)

(Joins sheet 43)

T. 99 N.

T. 100 N.

DOUGLAS COUNTY

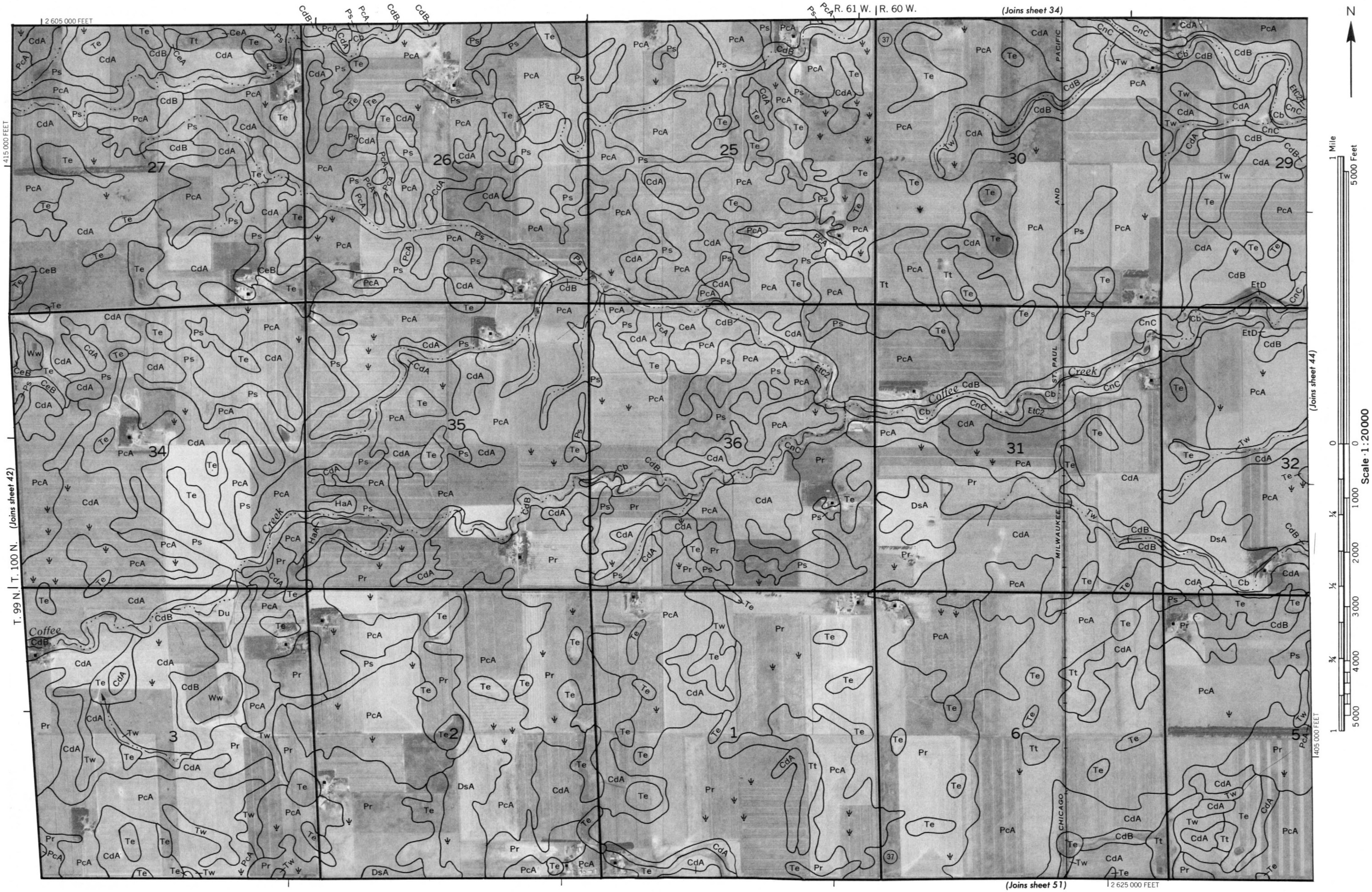
Creek

Coffee

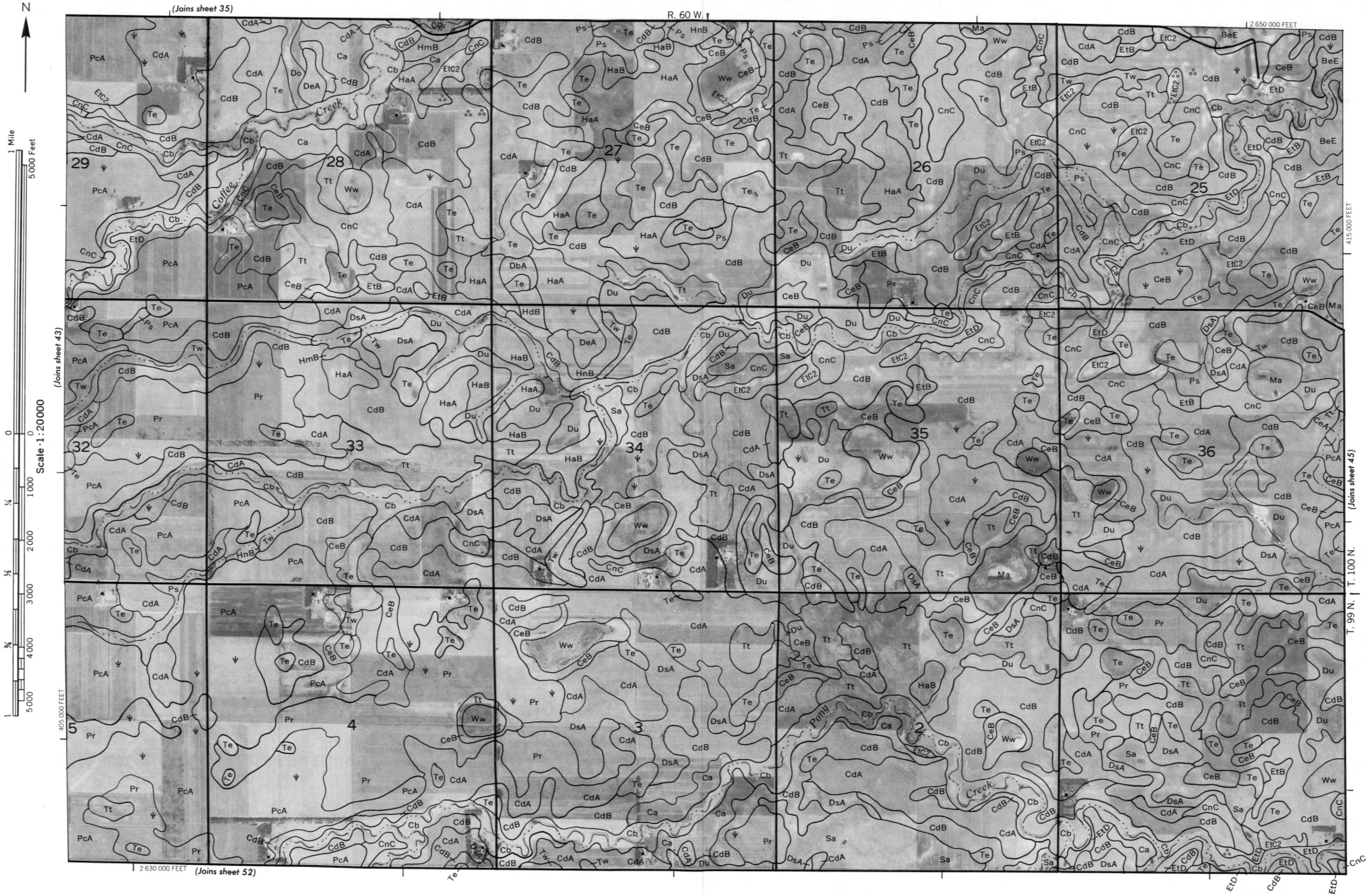
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 42

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 44



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 44

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 45

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 655 000 FEET

R. 59 W.

(Joins sheet 36)

415 000 FEET

T. 99 N.

T. 100 N.

(Joins sheet 44)

(Joins sheet 46)

(Joins sheet 53)

2 675 000 FEET

405 000 FEET

N

1 Mile

5000 Feet

Scale · 1 : 20000

JAMES RIVER

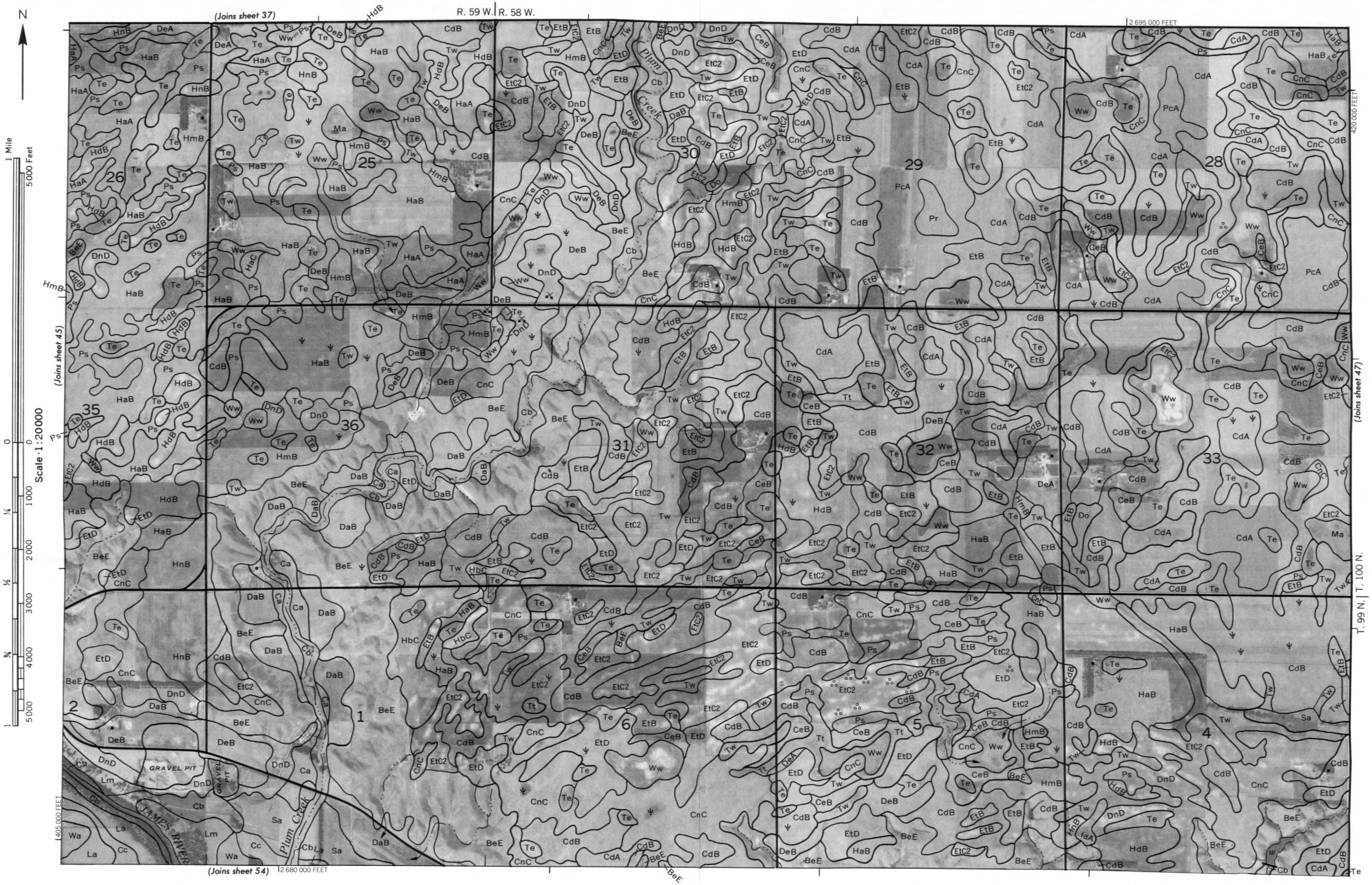
Twelvemile Creek

South Fork Twelvemile Creek

Pony Creek

MILLTOWN CEMETERY

Milltown



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 46

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO 47

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 700 000 FEET (Joins sheet 38) R. 58 W. | R. 57 W. N

420 000 FEET

T. 100 N. (Joins sheet 46)

T. 99 N.

410 000 FEET

(Joins sheet 55)

2 720 000 FEET

(Joins sheet 48)

Clayton

ST. PETER'S CEMETERY

St. Peter's Church

Unity Church

Elm Creek

Scale 1:20000

1 Mile

5000 Feet

(48)

N

(Joins sheet 39)

R. 57 W.

2 745 000 FEET

420 000 FEET

(Joins sheet 47)

410 000 FEET

2 725 000 FEET (Joins sheet 56)

T. 99 N. | T. 100 N. (Joins sheet 49)

Salem Church

Wolf Creek

GRAVEL PIT

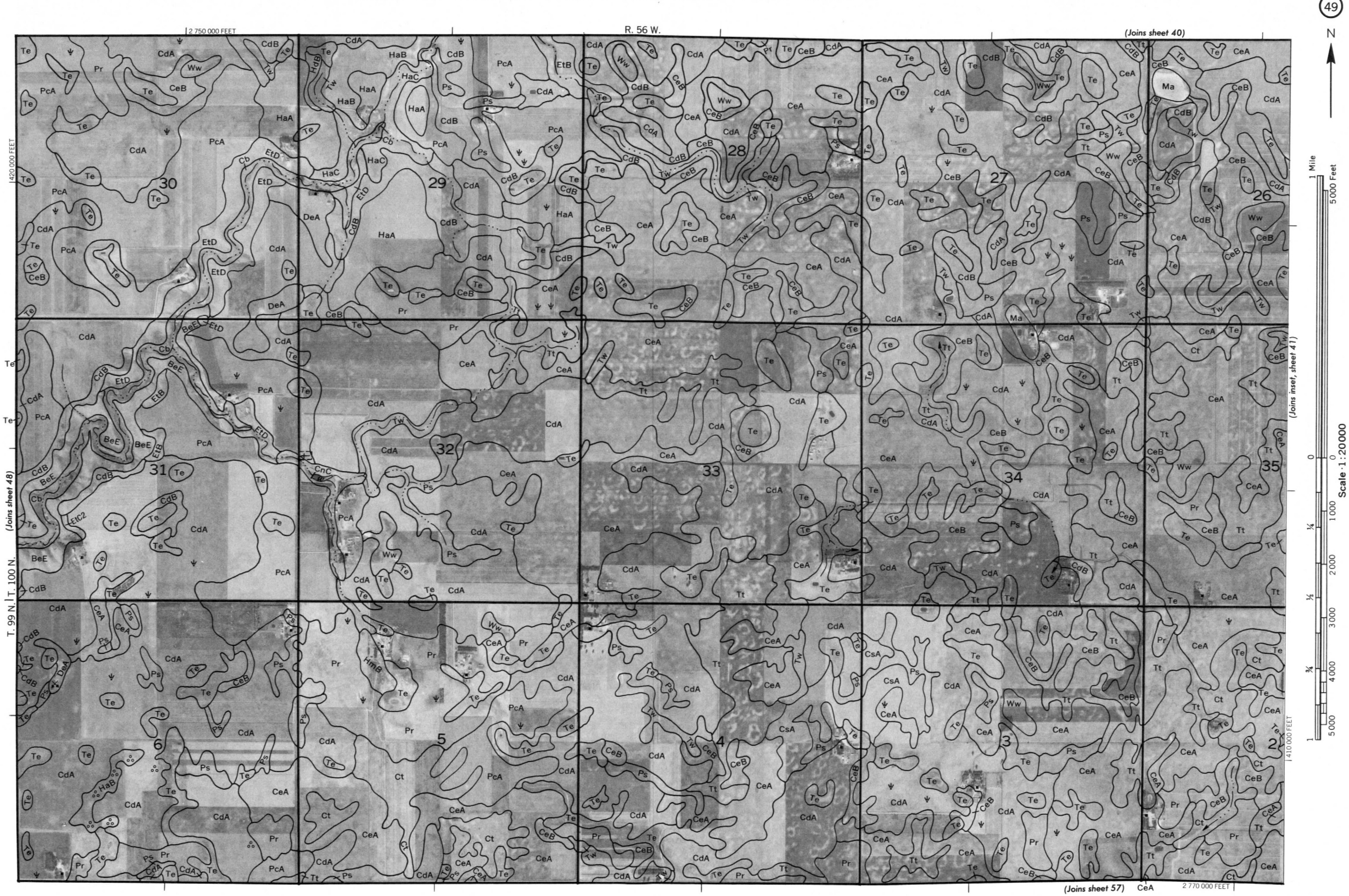
1 Mile

5000 Feet

Scale-1:20000

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 48



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 50

50

N

1 Mile

5000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

(Joins sheet 42)

R. 61 W.

2 605 000 FEET

1 400 000 FEET

T. 99 N.

DOUGLAS COUNTY

1 390 000 FEET

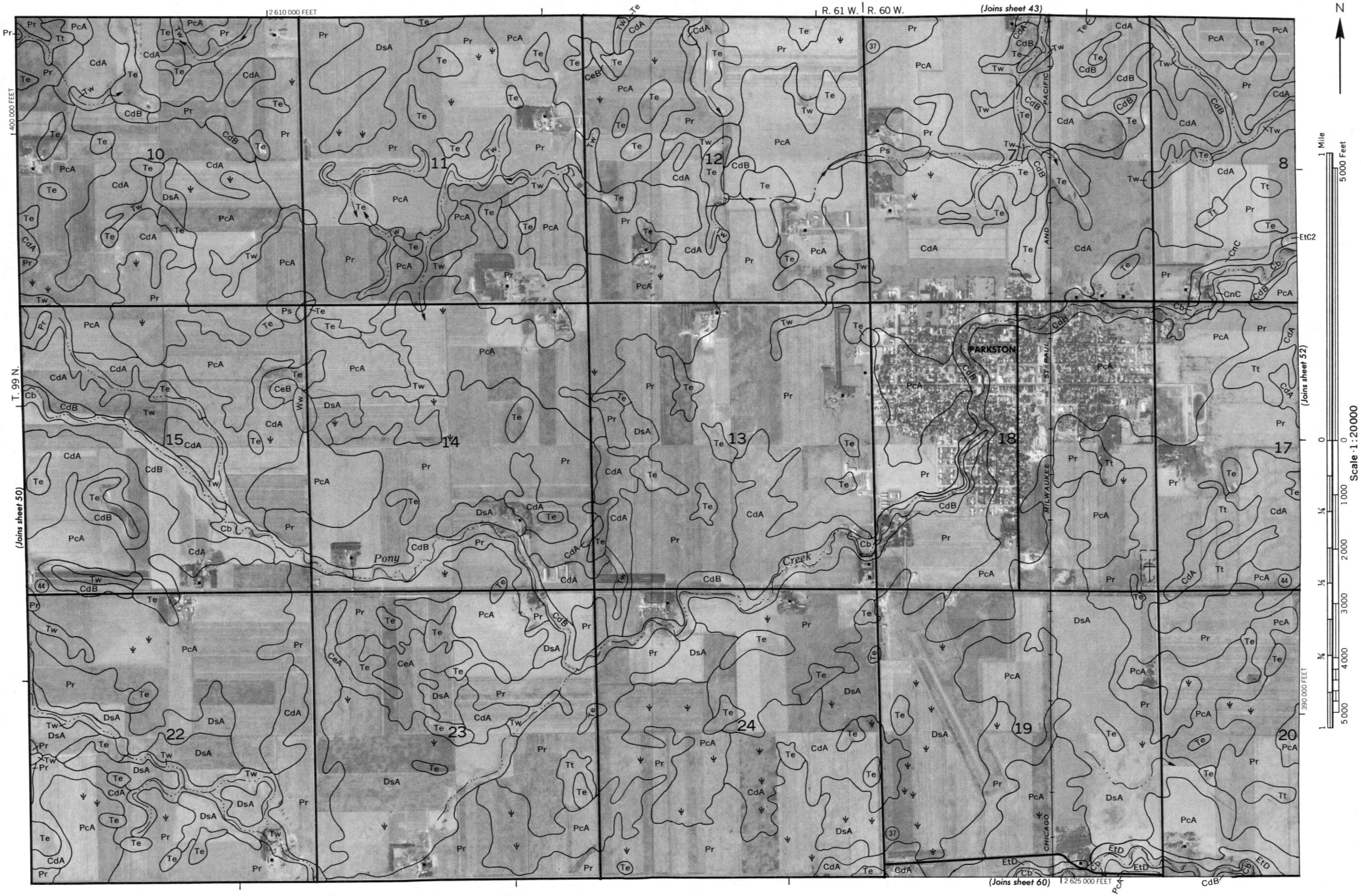
2 585 000 FEET

(Joins sheet 59)

(Joins sheet 51)

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 50



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 51
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

R. 60 W.

T. 99 N.

(Joins sheet 44)

(Joins sheet 51)

(Joins sheet 53)

(Joins sheet 61)

2 650 000 FEET

400 000 FEET

390 000 FEET

1 Mile 5000 Feet

Scale 1:20000

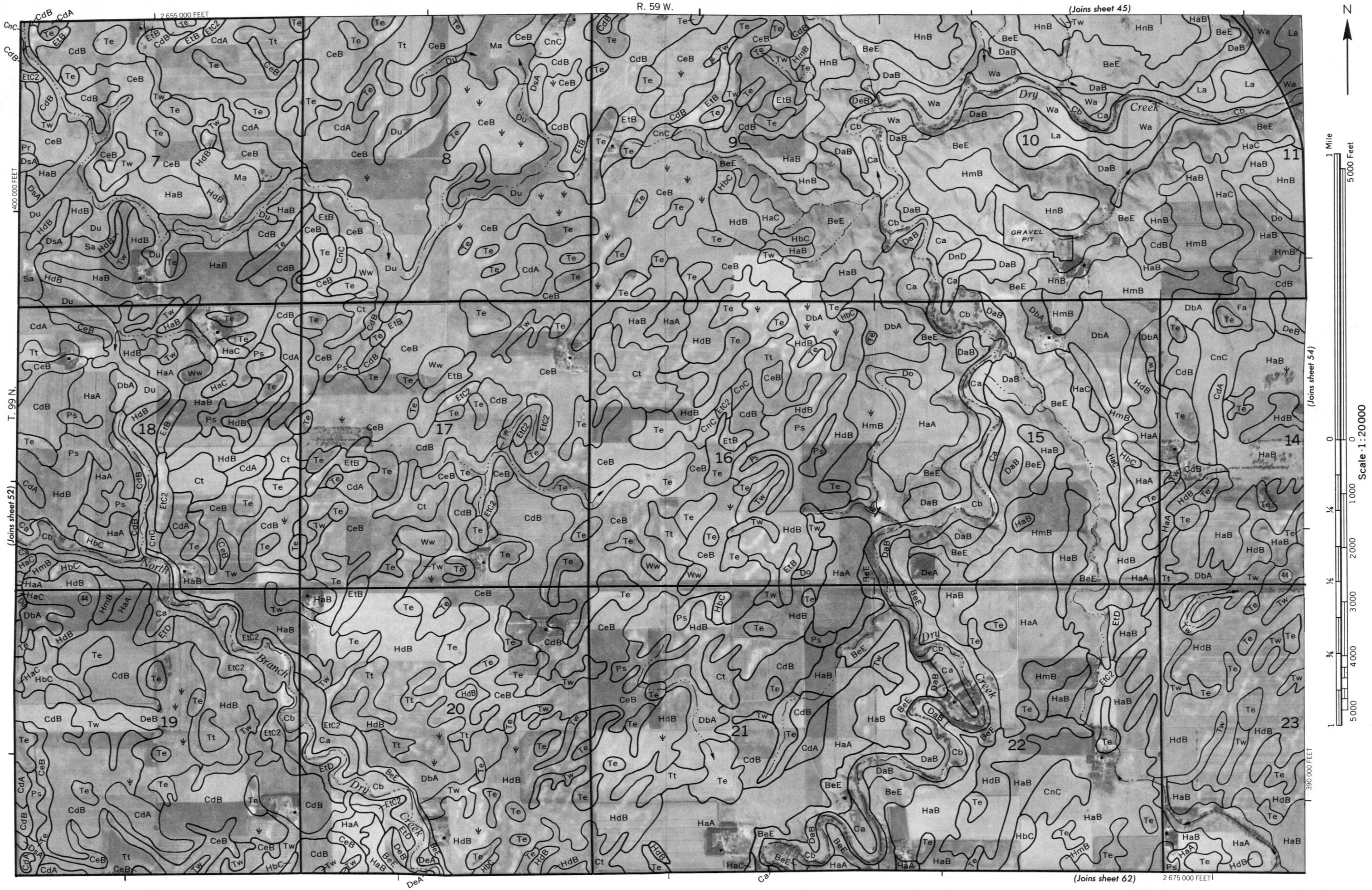
Sewage Disposal Area

Pony Creek

Dry Creek

North Branch

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

(Joins sheet 46)

R. 59 W. | R. 58 W.

2 695 000 FEET

405 000 FEET

T. 99 N.

(Joins sheet 53)

(Joins sheet 55)

(Joins sheet 63)

2 680 000 FEET

390 000 FEET

1 Mile

5 000 Feet

Scale 1:20000

0 0 ¼ 1000 ½ 2000 ¾ 4000 1 5000

Plum Creek

Dry Creek

JAMES RIVER

GRAVEL PIT

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 55

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 700 000 FEET

405 000 FEET

R. 58 W. | R. 57 W.

(Joins sheet 47)

T. 99 N.

(Joins sheet 54)

(Joins sheet 56)

(Joins sheet 64)

2 720 000 FEET

395 000 FEET

N

1 Mile

5000 Feet

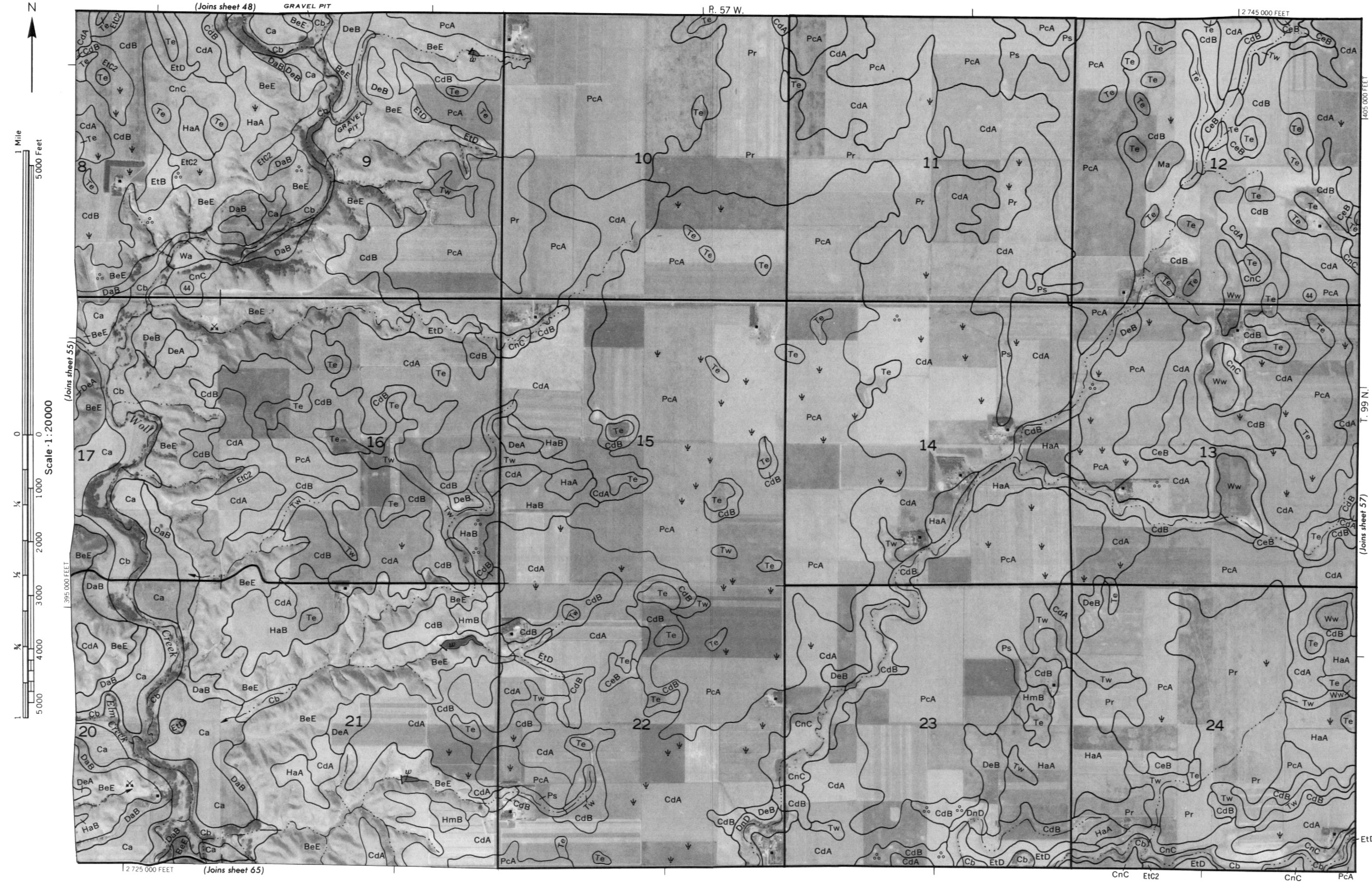
Scale 1:20000

Elm

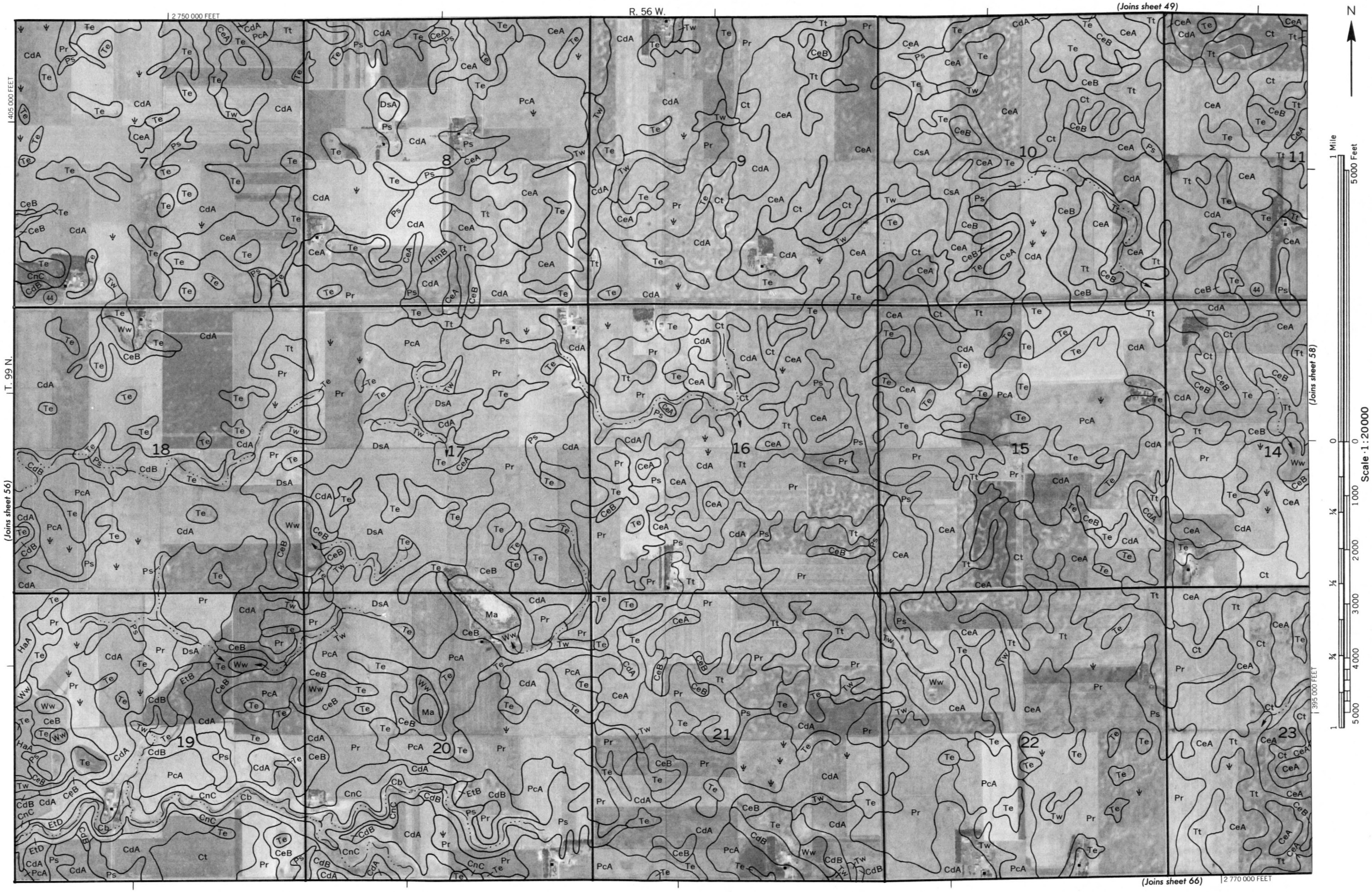
Creek

RIVER

JAMES



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

58

N

1 Mile
5000 Feet
Scale 1:20000

(Joins inset, sheet 41) R. 56 W. 2 780 000 FEET

405 000 FEET

T. 99 N.

(Joins sheet 57)

COUNTY

TURNER

395 000 FEET

(Joins inset) 2 775 000 FEET

(Joins sheet 58) R. 56 W. 2 780 000 FEET

390 000 FEET

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC

(Joins sheet 66)

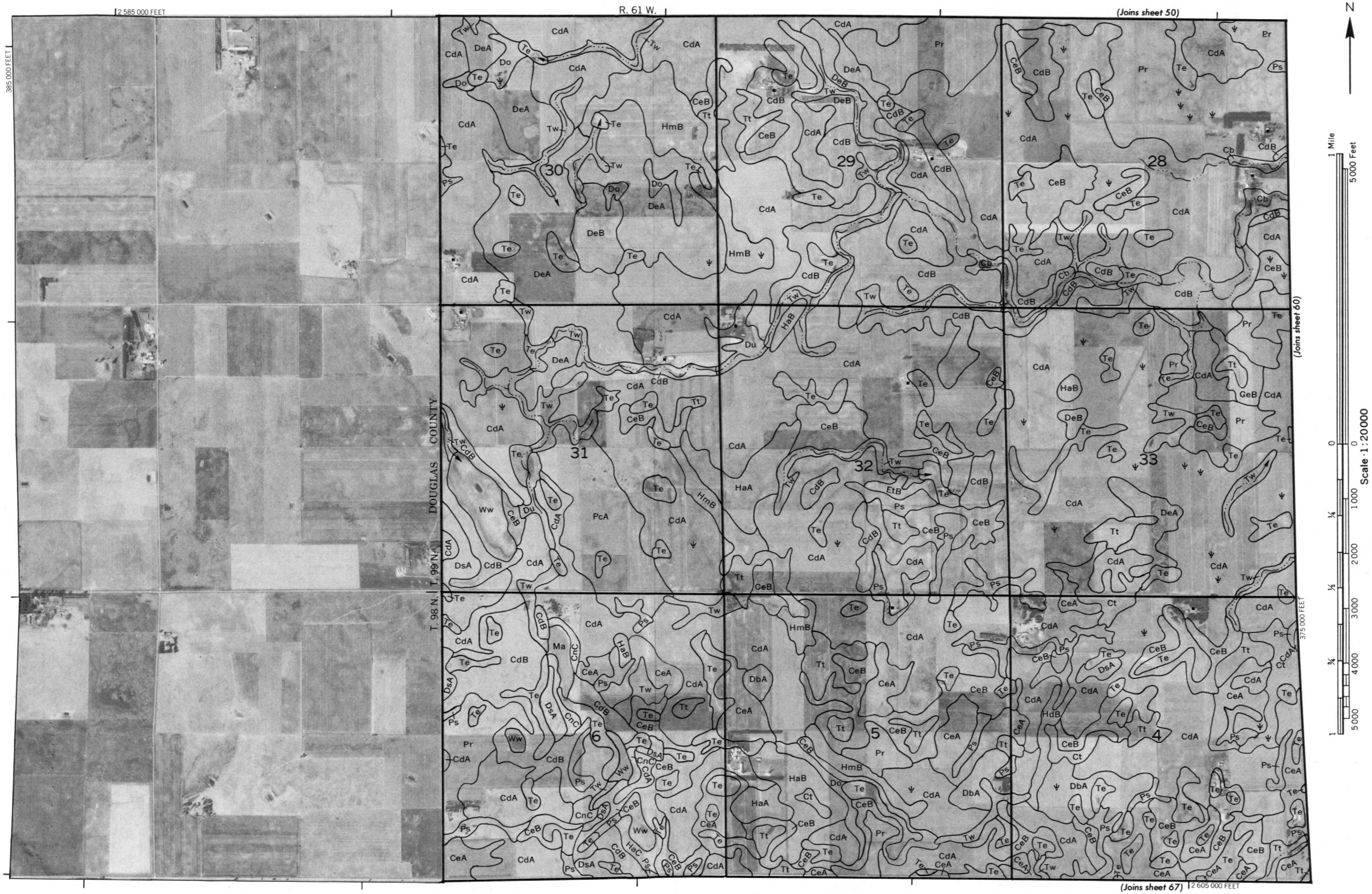
380 000 FEET

T. 98 N.

EtD (Joins sheet 75) 2 775 000 FEET

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 58



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 59

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

(Joins sheet 51)

R. 61 W. | R. 60 W.

2 625 000 FEET

385 000 FEET

375 000 FEET

2 610 000 FEET

(Joins sheet 59)

(Joins sheet 68)

(Joins sheet 61)

T. 98 N. | T. 99 N.

1 Mile 5 000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1 000 2000 3000 4000 5000

PACIFIC AND ST PAUL MILWAUKEE CHICAGO

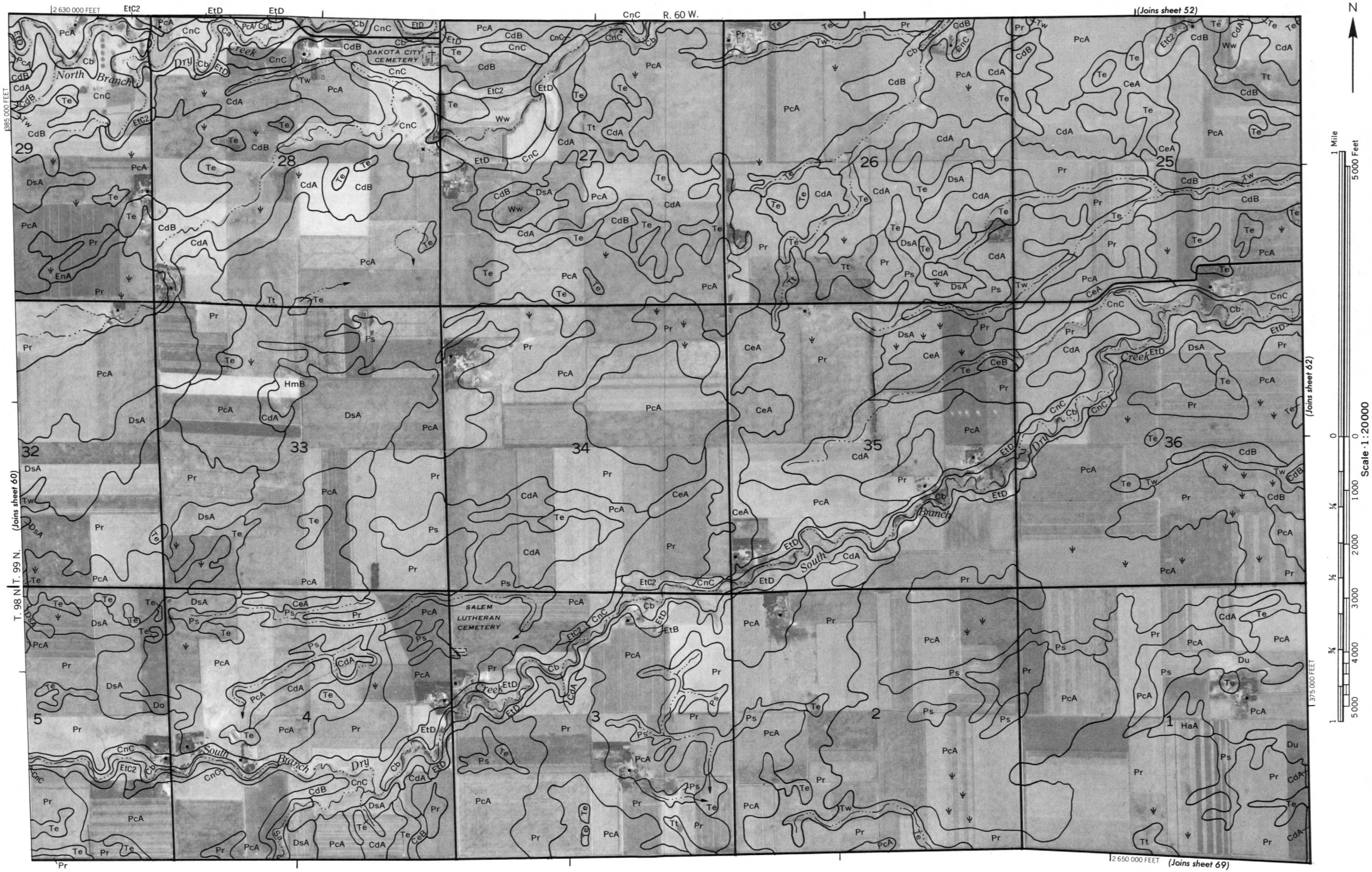
EIGENFELD CEMETERY

North Branch Dry Creek

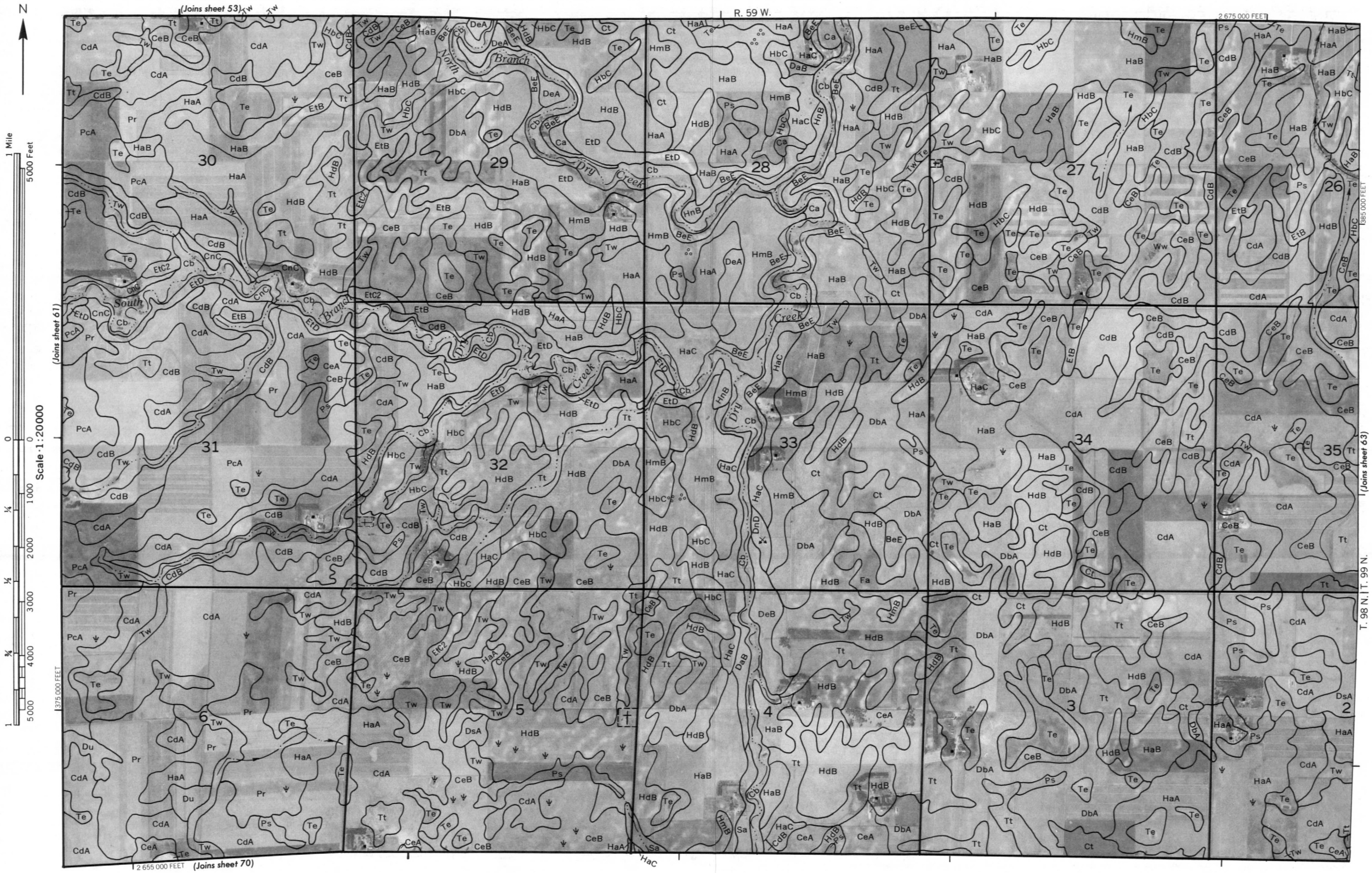
27 26 25 30 29 34 35 36 31 32 3 2 1 6 5

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

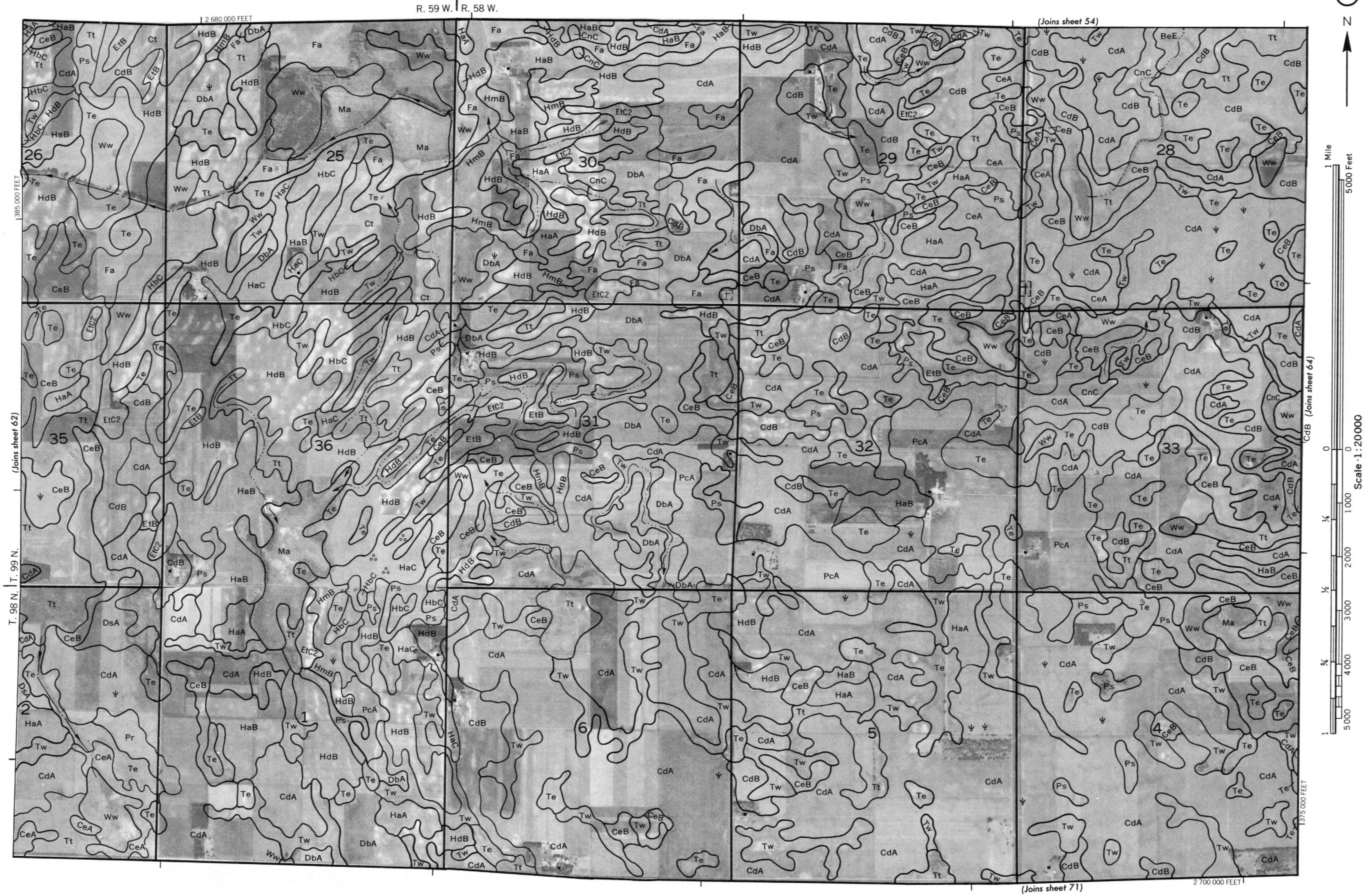
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 60



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



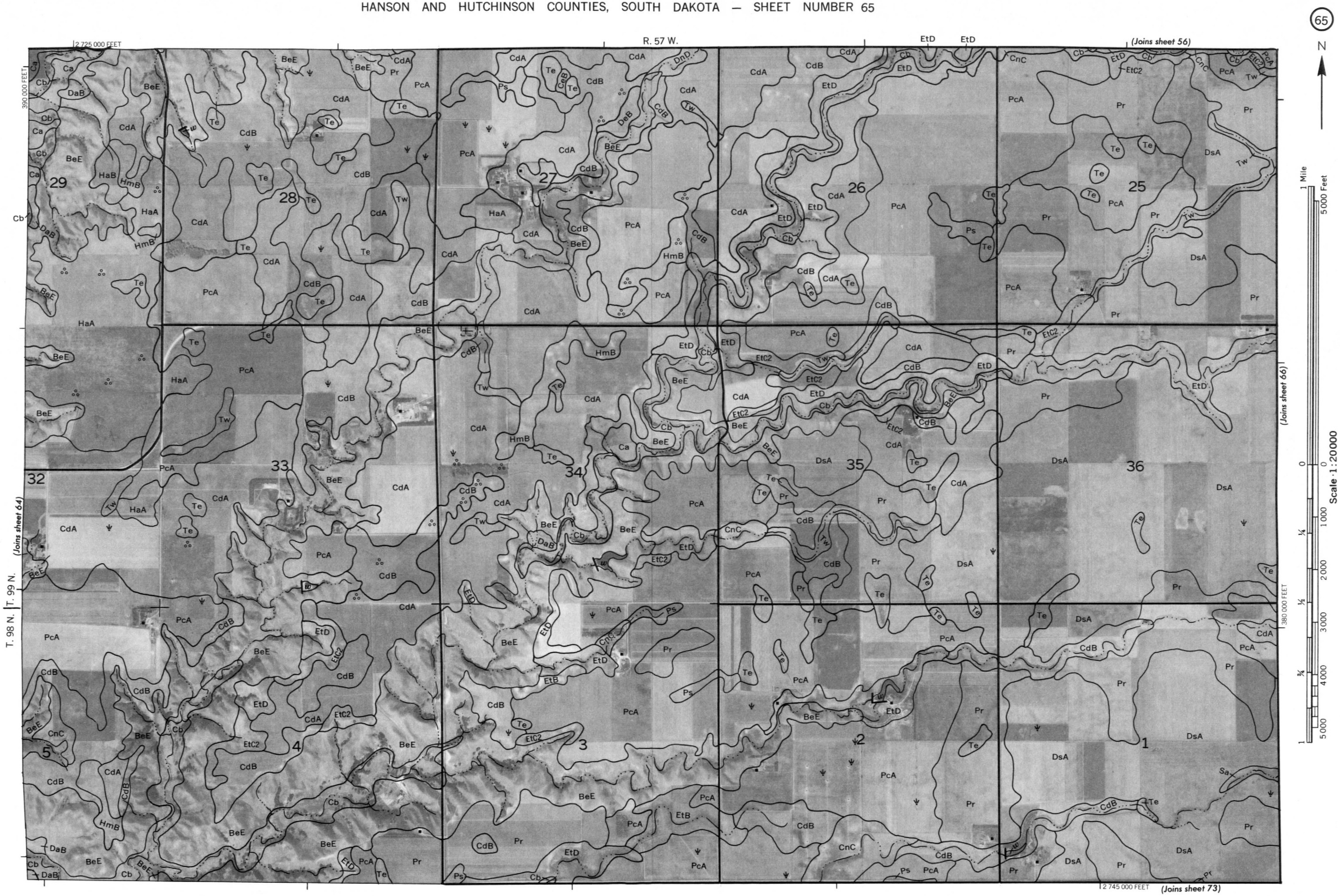
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



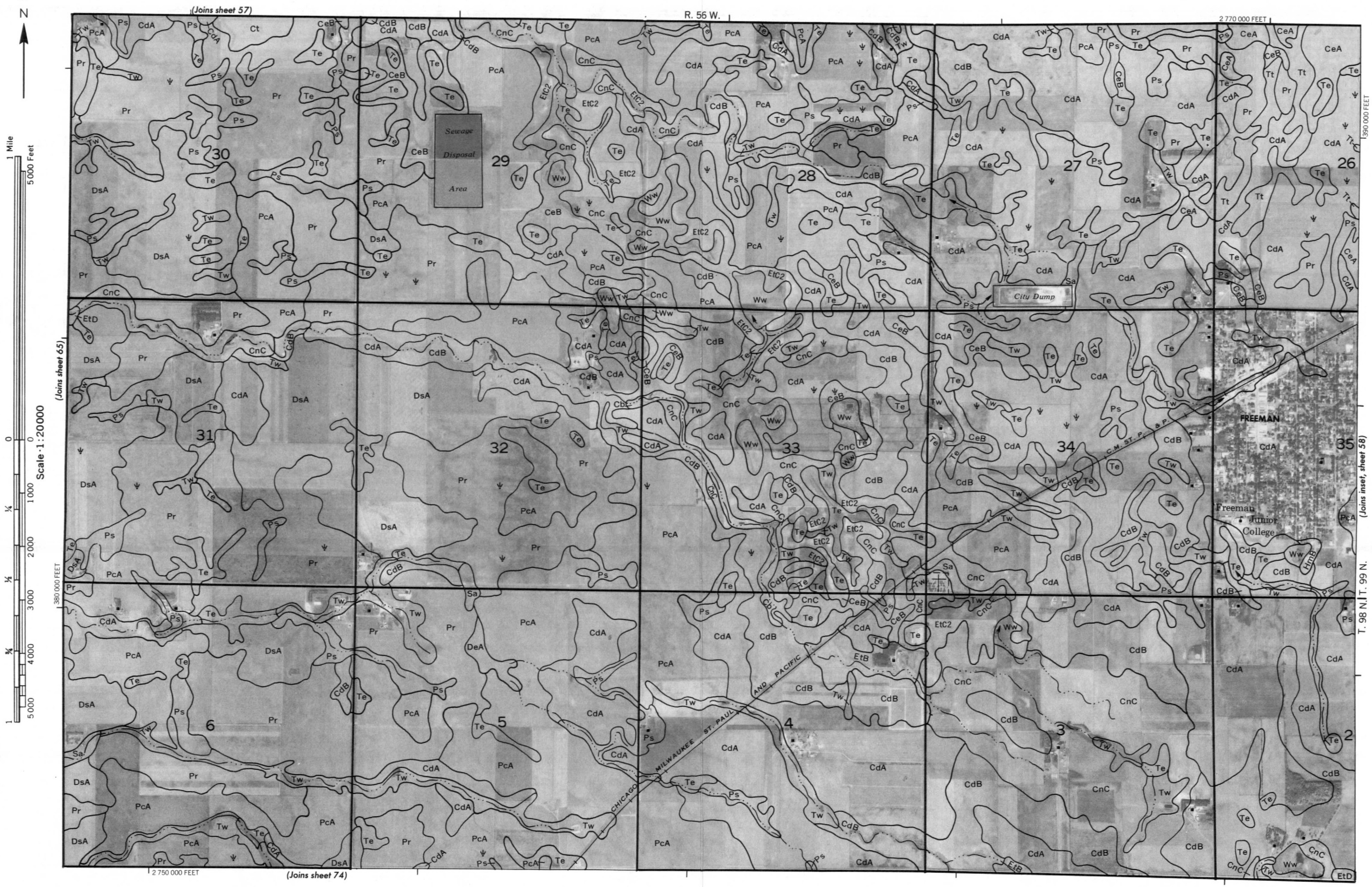
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 63

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

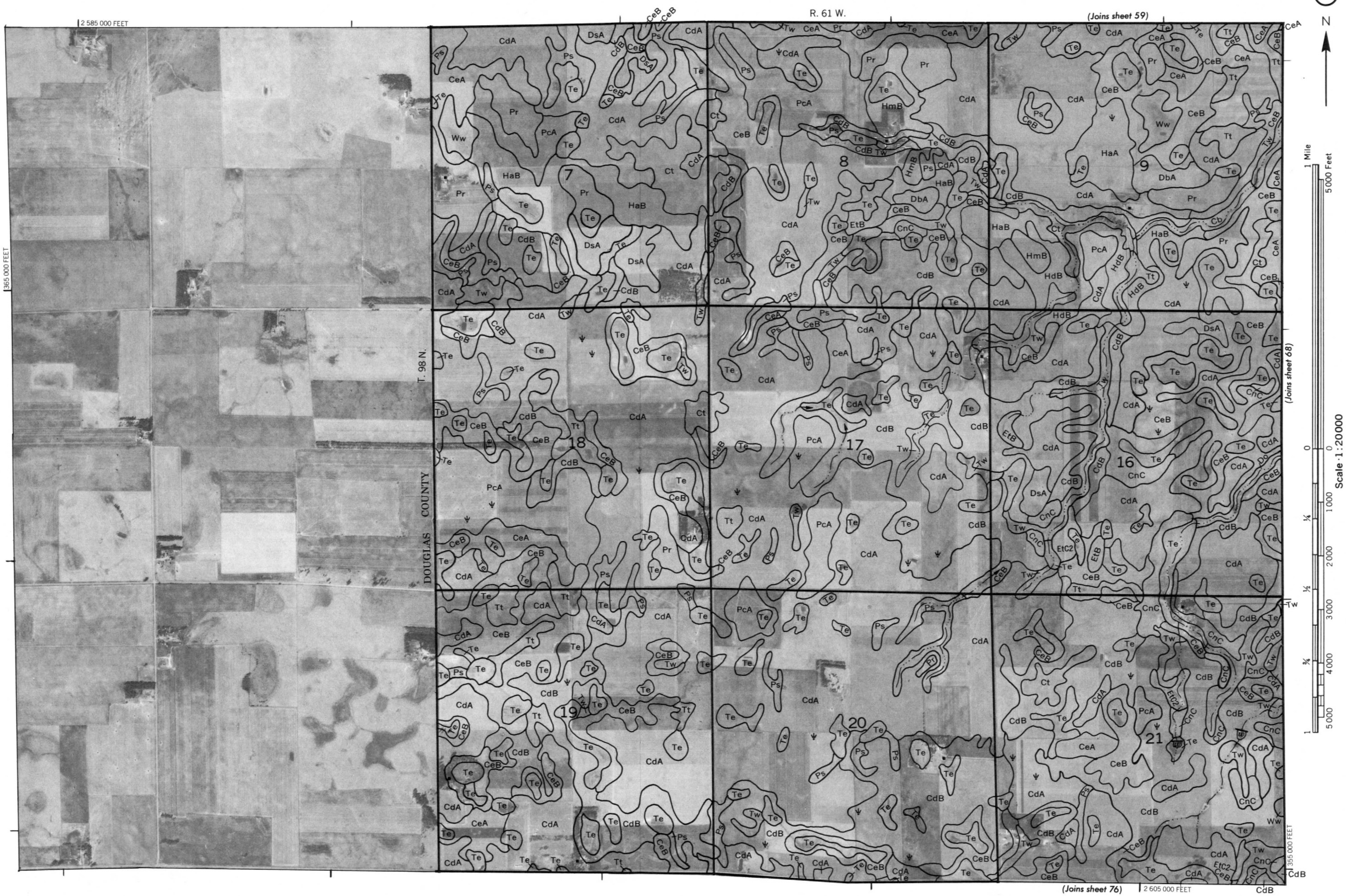
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 67

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

68

N

1 Mile 5000 Feet

Scale · 1 : 20000

0 0 ¼ 1000 ½ 2000 ¾ 4000 1 5000

R. 61 W. | R. 60 W.

T. 98 N.

2 630 000 FEET

370 000 FEET

355 000 FEET

2 610 000 FEET

(Joins sheet 60)

(Joins sheet 67)

(Joins sheet 69)

(Joins sheet 77)

Dry Creek

South Branch

PACIFIC

ST. PAUL

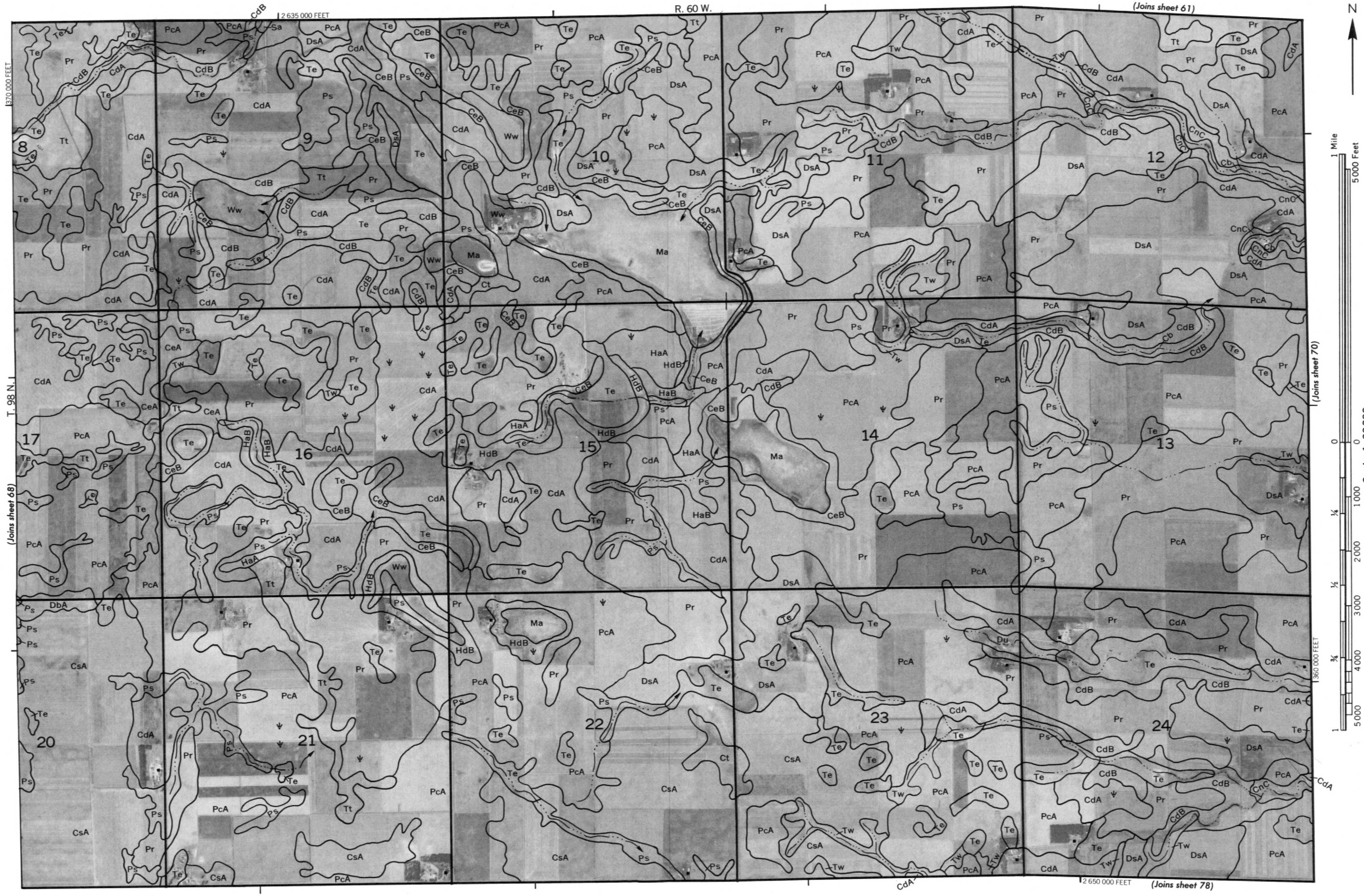
MILWAUKEE

CHICAGO

Beardsley

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 68



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

(Joins sheet 62)

R. 59 W.

2 675 000 FEET

(Joins sheet 69)

T. 98 N.

(Joins sheet 71)

360 000 FEET

2 655 000 FEET

(Joins sheet 79)

1 Mile 5000 Feet

Scale 1:20000

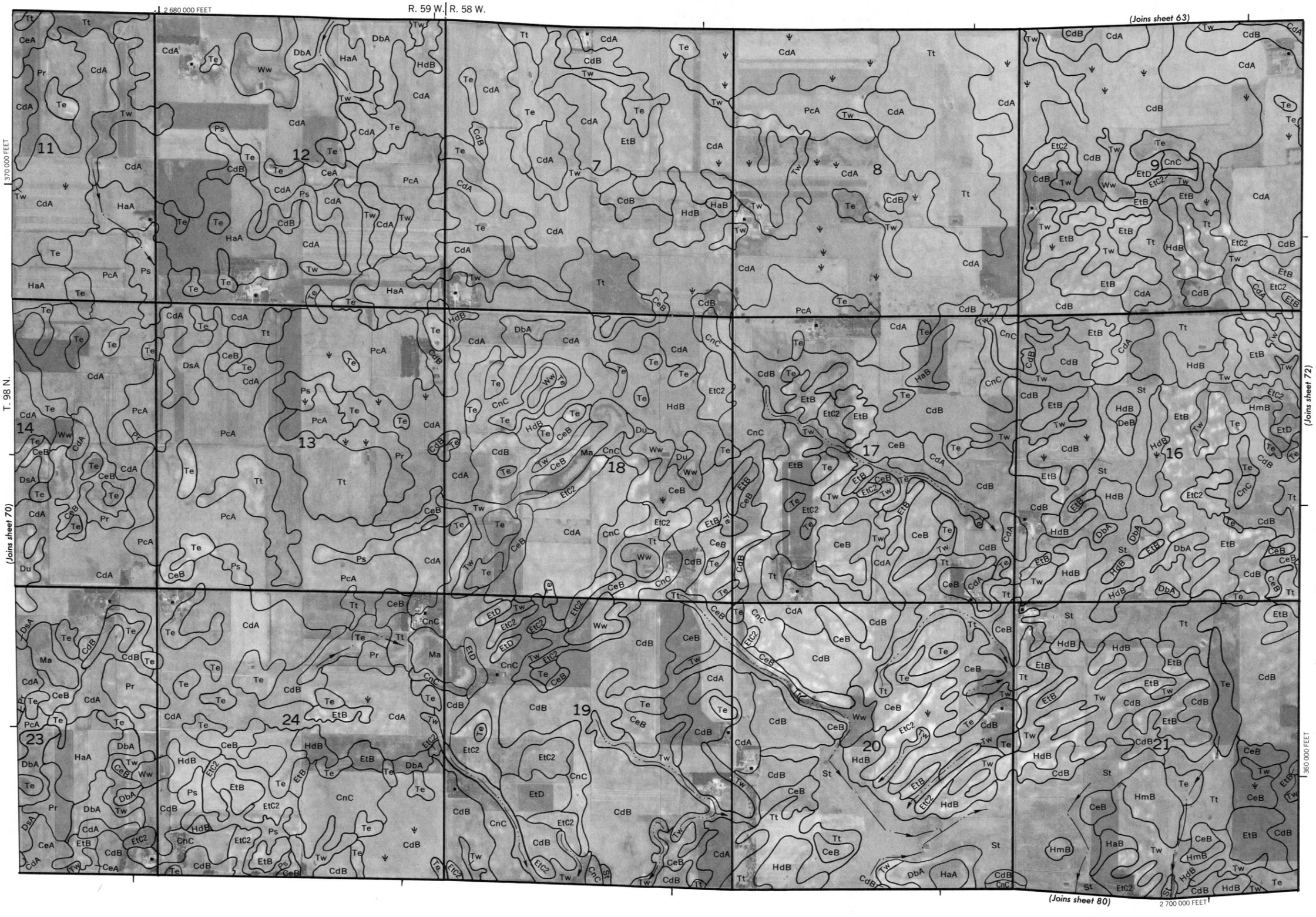
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 70

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 71

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 71

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



72

N

1 Mile
5000 Feet

Scale 1:20000

(Joins sheet 64)

(Joins sheet 71)

(Joins sheet 81)

(Joins sheet 73)

R. 58 W. R. 57 W.

T. 98 N.

2 720 000 FEET

370 000 FEET

360 000 FEET

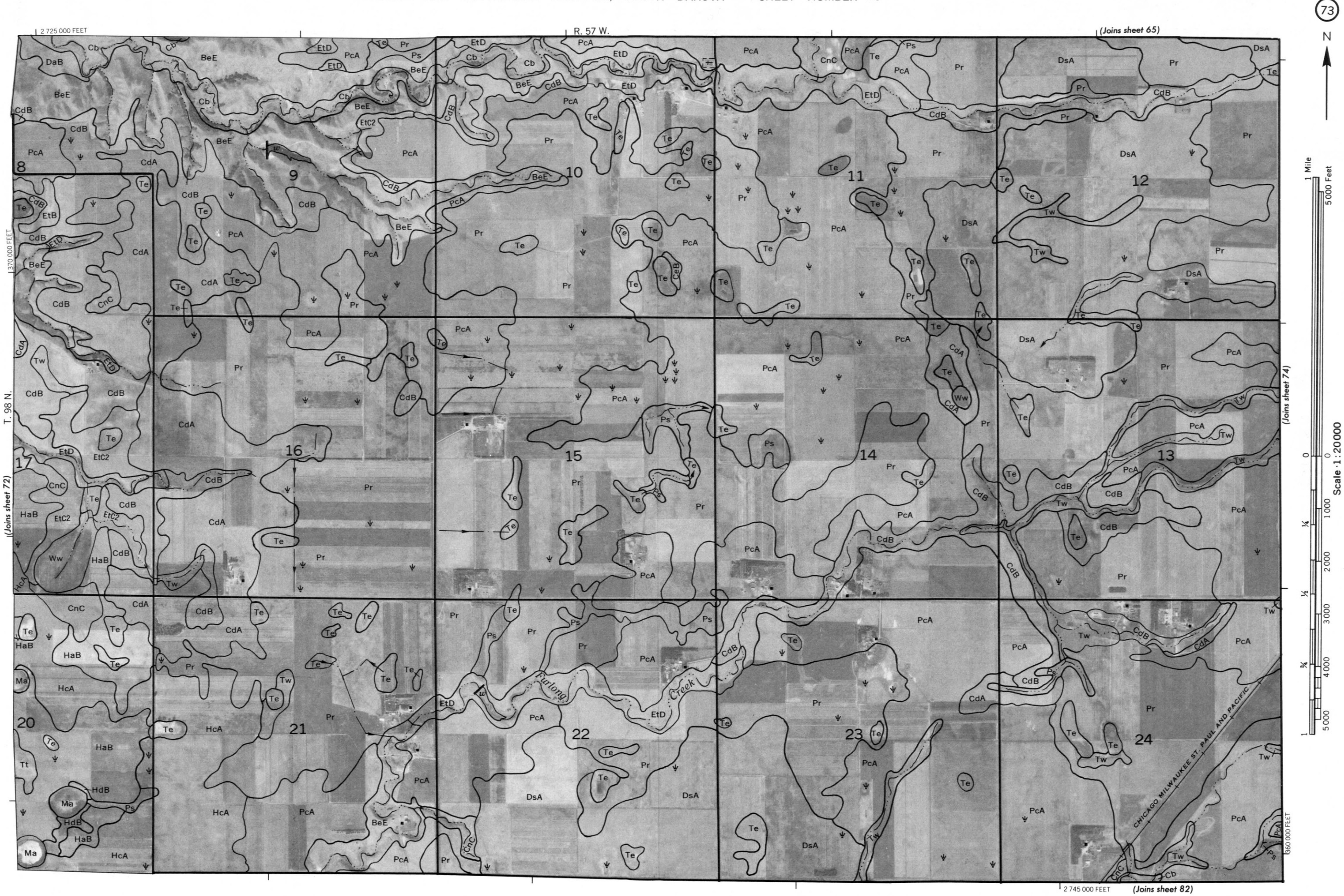
2 705 000 FEET

JAMES RIVER

JAMES RIVER

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 72



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 73

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

(Joins sheet 66)

R. 56 W.

2 770 000 FEET

375 000 FEET

T. 98 N.

(Joins sheet 73)

360 000 FEET

2 750 000 FEET

(Joins sheet 83)

(Joins sheet 75)

1 Mile

5000 Feet

Scale 1:20000

PACIFIC AND

ST. PAUL

MILWAUKEE

CHICAGO

7 8 9 10 11

18 17 16 15 14

19 20 21 22 23

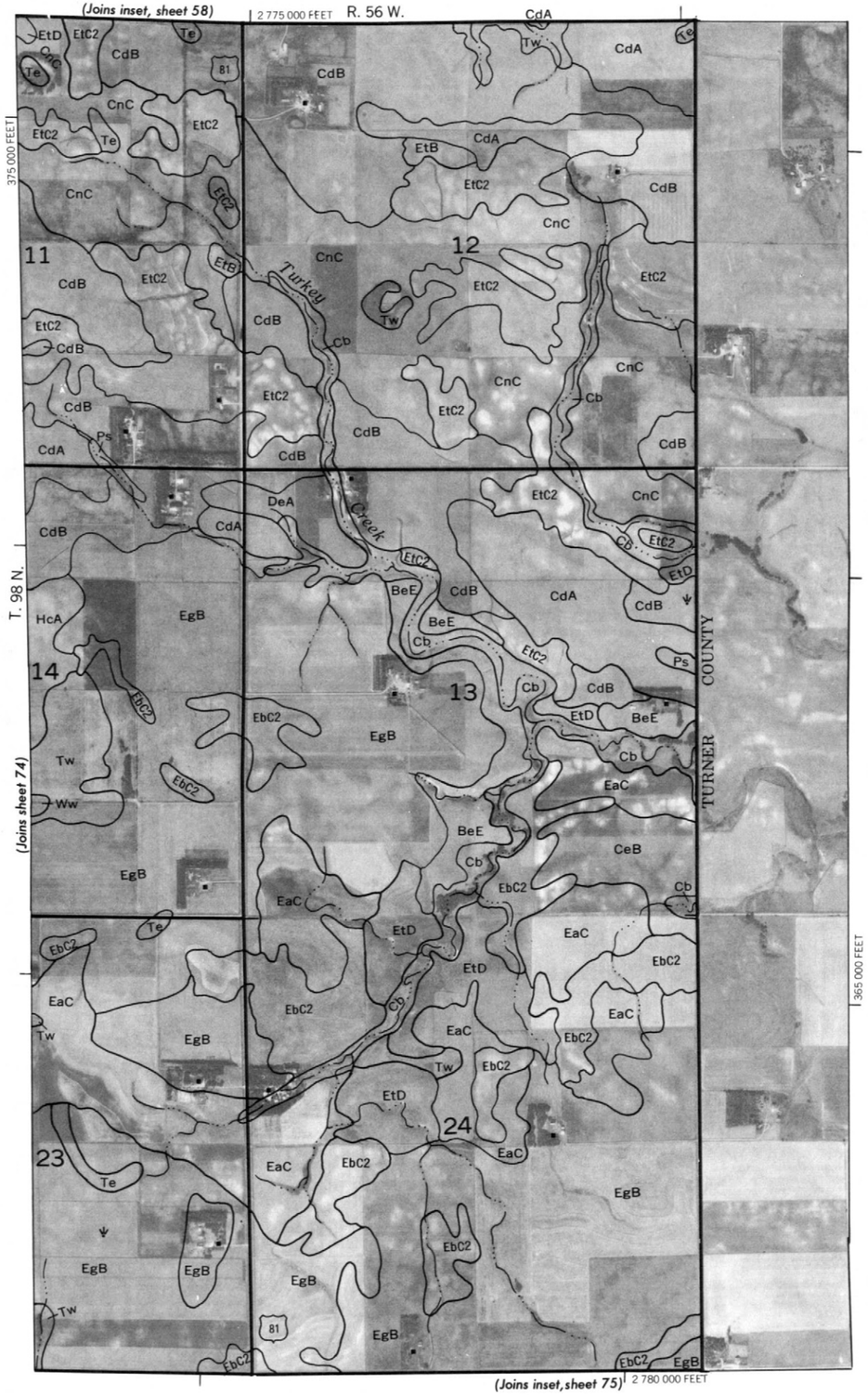
PcA Pr Te Tw DsA CdA Ps CdB EtB EtC2 EtD CnC DeA HcA HmB Ww HaB EgB EaC

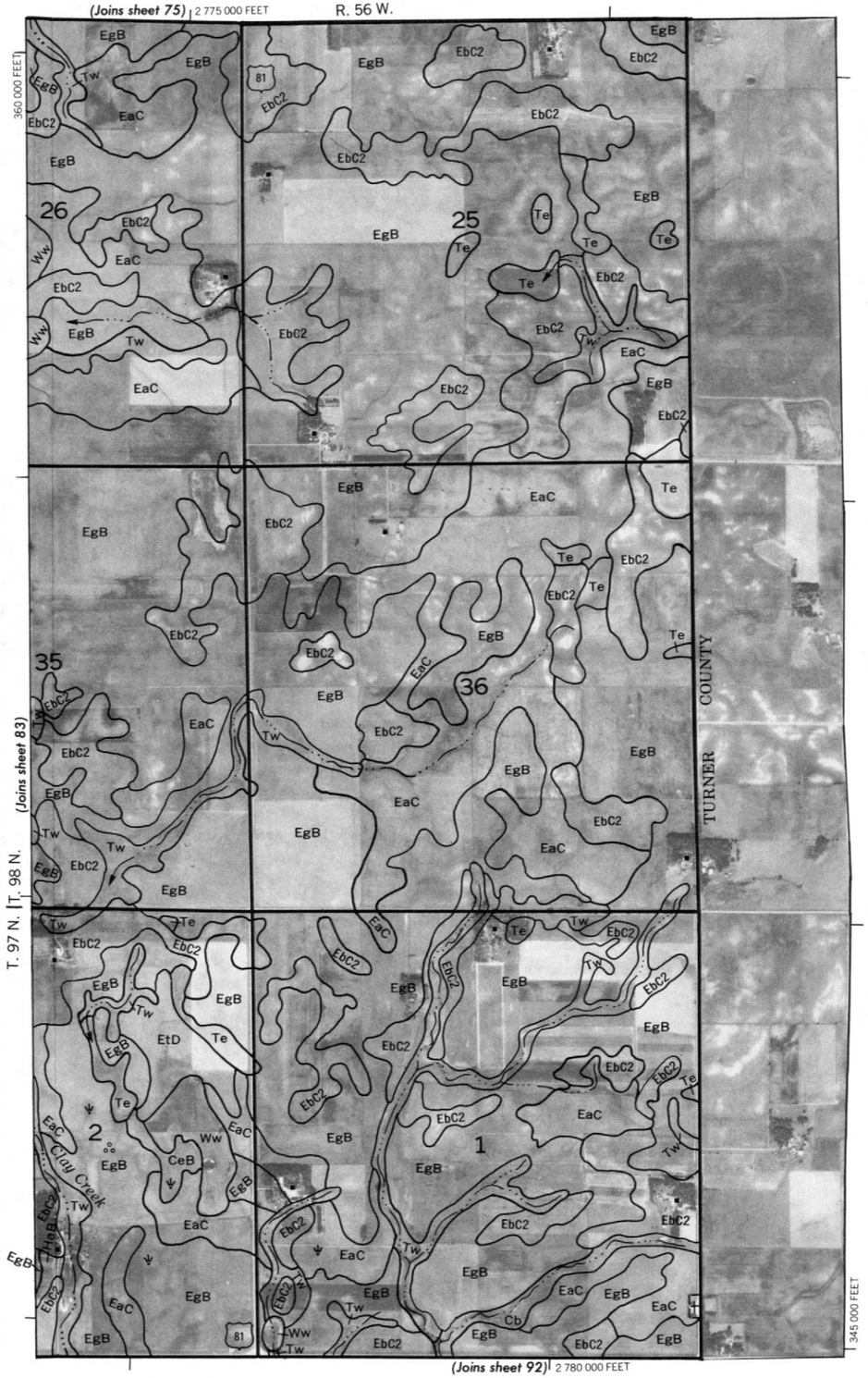
This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

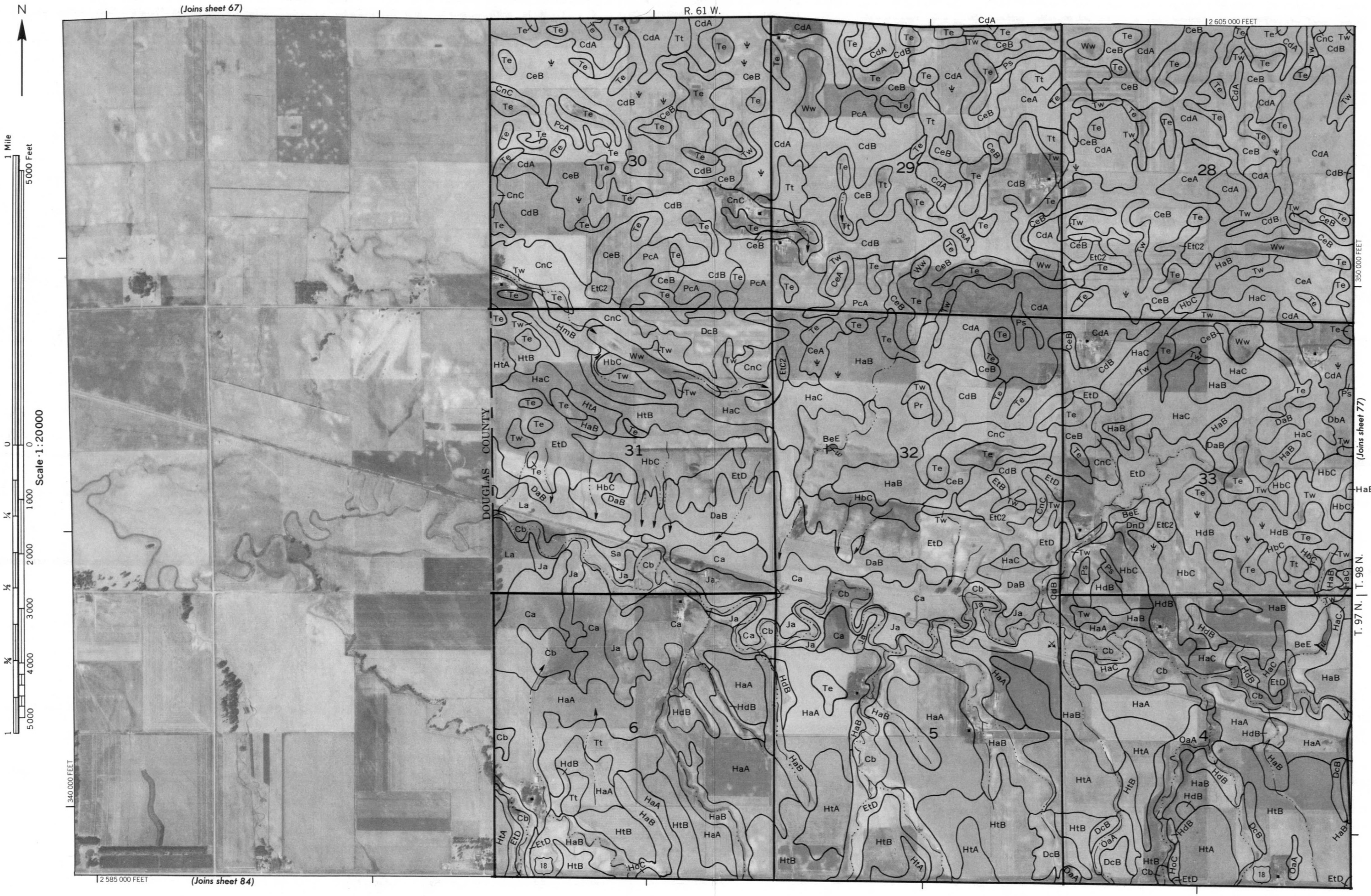
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 74

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 75

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.







This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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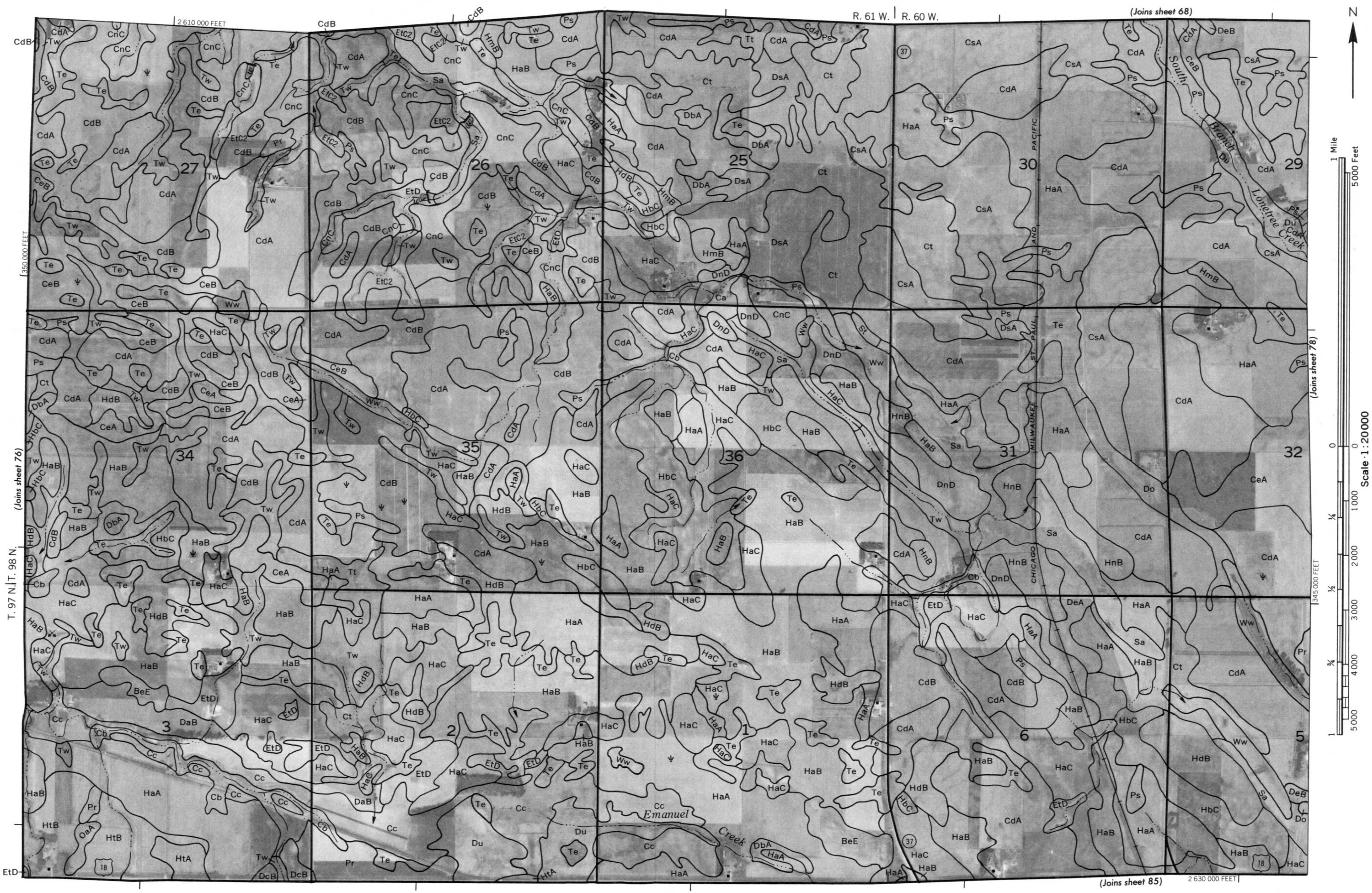


HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 77

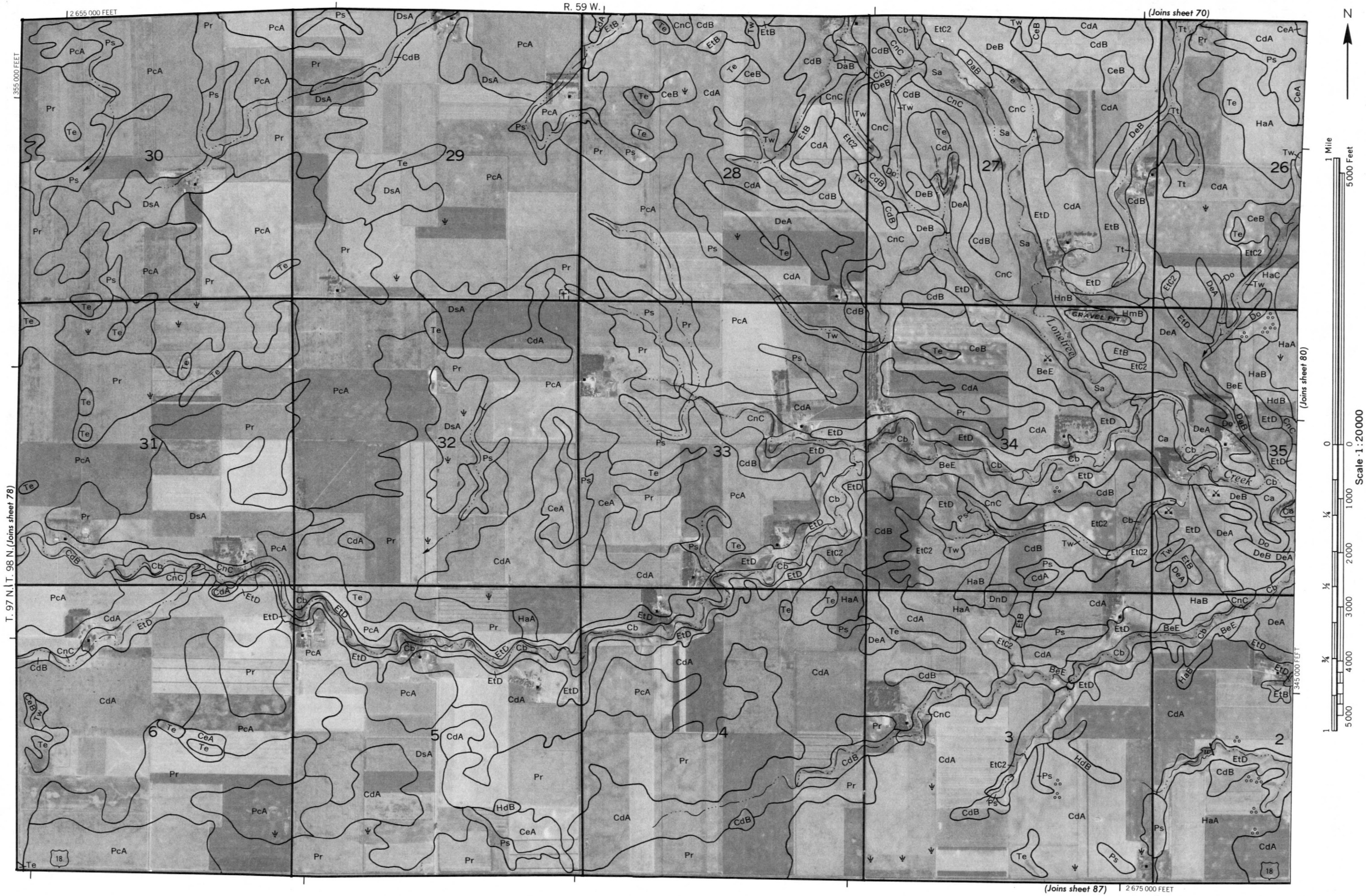
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 78

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

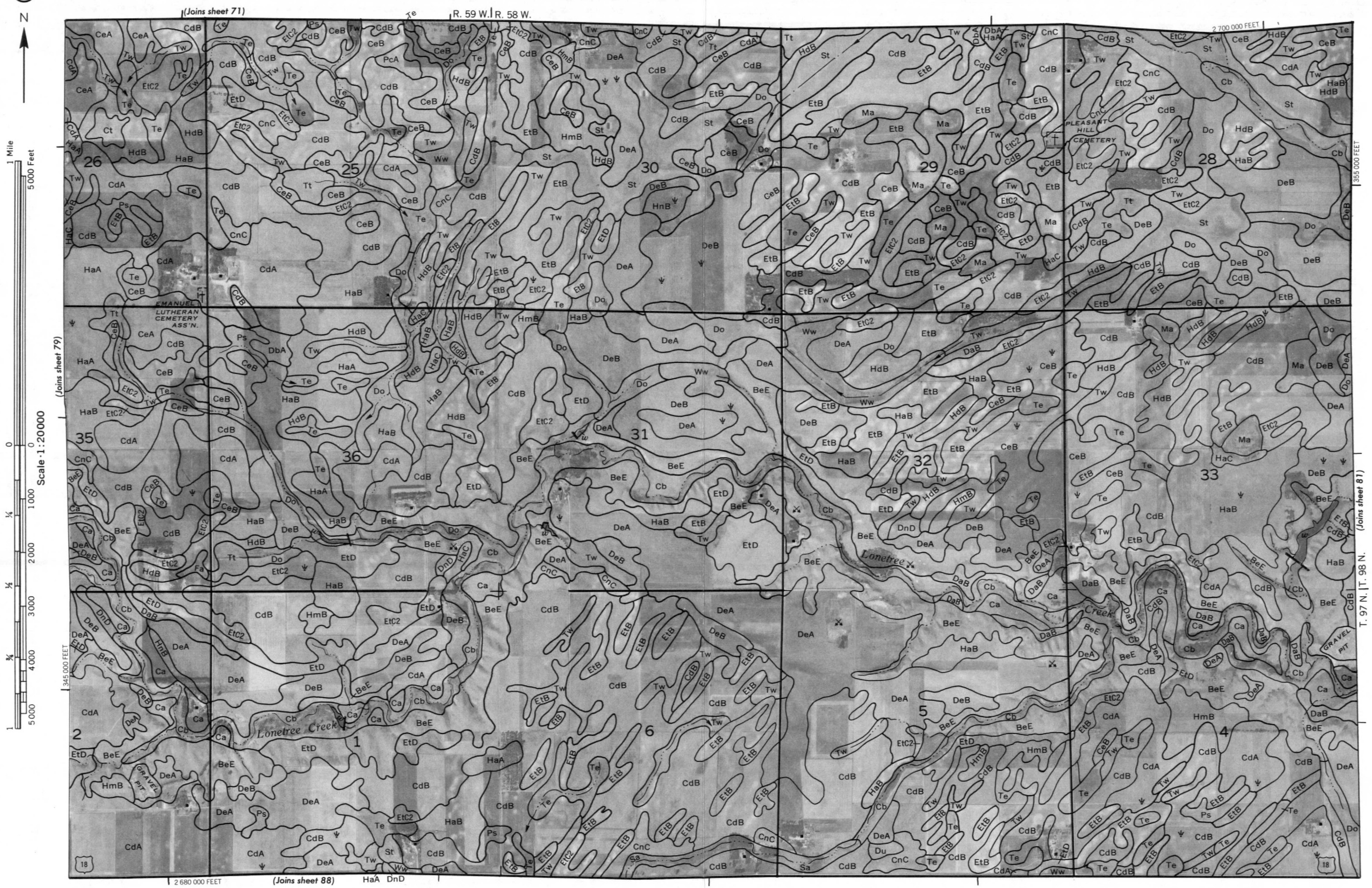
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 78

79

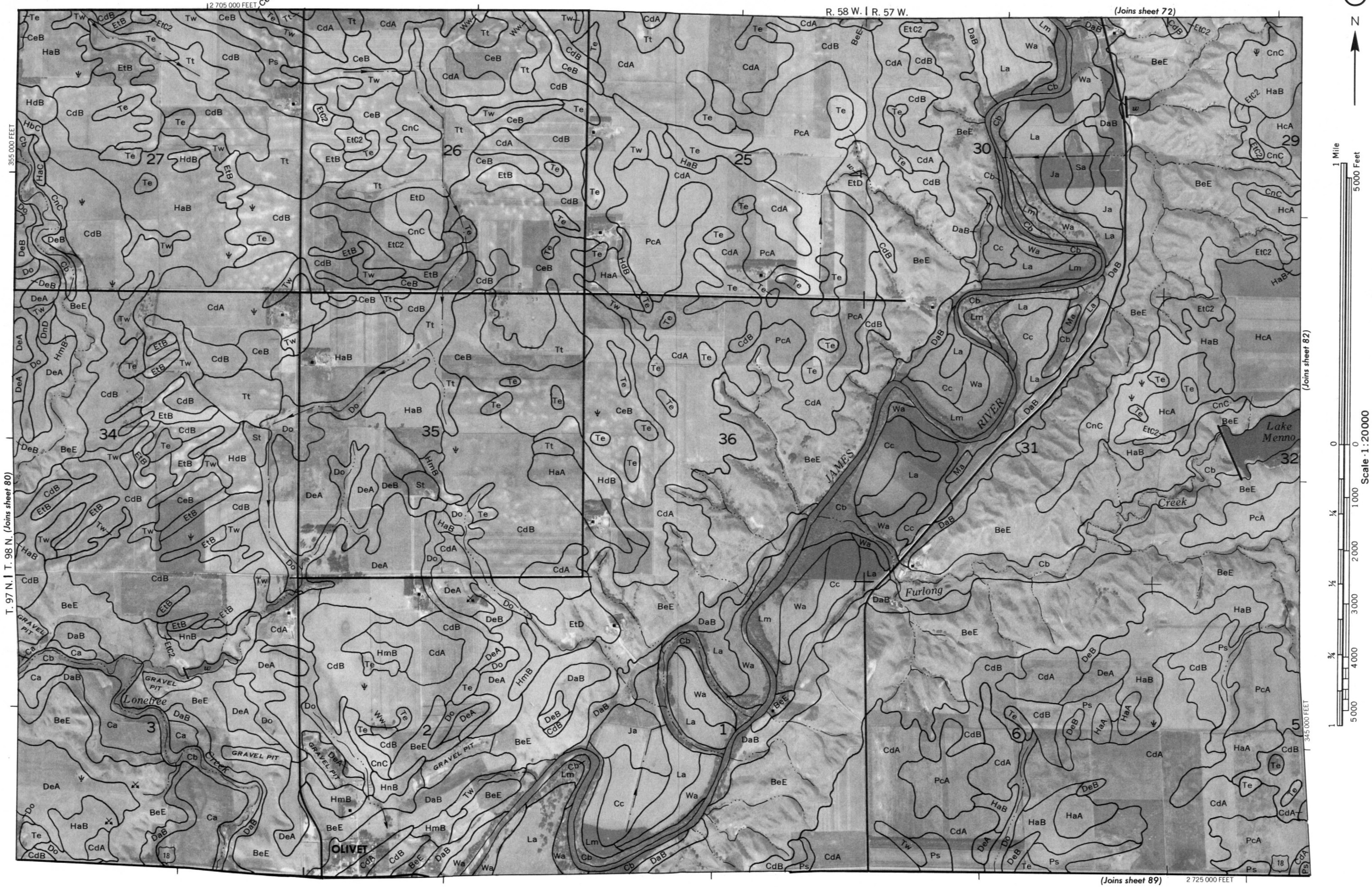


This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 80



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

(Joins sheet 73)

R. 57 W.

2 745 000 FEET

355 000 FEET

T. 98 N.

T. 97 N.

(Joins sheet 81)

(Joins sheet 83)

345 000 FEET

(Joins sheet 90)

2 730 000 FEET

1 Mile

5000 Feet

Scale 1:20000

Lake Memo

Menno

PACIFIC AND ST. PAUL

MILWAUKEE AND CHICAGO

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 82

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 83

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid (ticks and land division corners, if shown, are approximately positioned.

83

N

2 750 000 FEET

355 000 FEET

R. 56 W.

(Joins sheet 74)

T. 98 N.

T. 97 N.

(Joins sheet 82)

(Joins inset, sheet 75)

(Joins sheet 91)

2 770 000 FEET

345 000 FEET

30 29 28 27 26

31 32 33 34 35

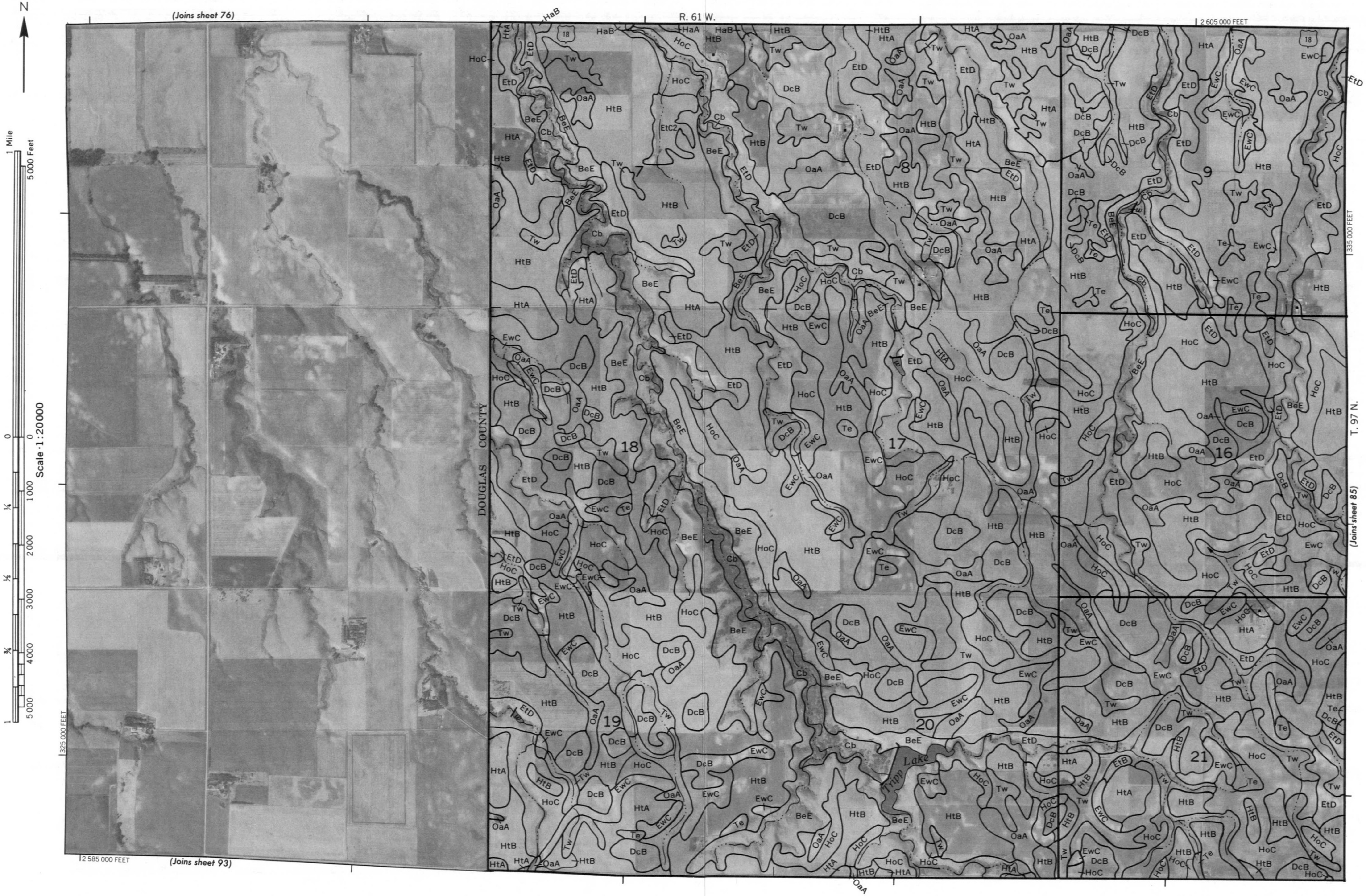
6 5 4 3 2

1 Mile

5000 Feet

Scale 1:20000

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 84



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 85

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

R. 61 W. R. 60 W.

T. 97 N.

2 610 000 FEET

335 000 FEET

325 000 FEET

2 630 000 FEET

(Joins sheet 77)
(Joins sheet 84)
(Joins sheet 86)
(Joins sheet 94)

Tripp

County Fair Grounds

SANITARY LAND FILL

GRACE HILL CEM.

GRAVEL PIT

GRAVEL PIT

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC

Scale · 1:20000

1 Mile

5000 Feet

N

(Joins sheet 78)

R. 60 W.

2 650 000 FEET

340 000 FEET

T. 97 N.

Scale 1:20000

1 Mile 5000 Feet

0 0 1000 2000 3000 4000 5000

Sewage Disposal Area

South Branch Lonetree Creek

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC

Tripp

GRAVEL PIT

(Joins sheet 85)

(Joins sheet 87)

(Joins sheet 95)

325 000 FEET

2 635 000 FEET

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 87

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 655 000 FEET

340 000 FEET

R. 59 W.

(Joins sheet 79)

T. 97 N.

(Joins sheet 86)

(Joins sheet 88)

330 000 FEET

2 675 000 FEET

(Joins sheet 96)

DENNEWITZ CEMETERY ASS'N.

South Branch Longtree Creek

87

N

1 Mile

5000 Feet

Scale 1:20000

88

N

1 Mile
5000 Feet
Scale - 1:20000

(Joins sheet 80)

R. 59 W. | R. 58 W.

2 700 000 FEET

340 000 FEET

T. 97 N.

330 000 FEET

2 680 000 FEET

(Joins sheet 87)

(Joins sheet 97)

(Joins sheet 89)

Lonetree Creek

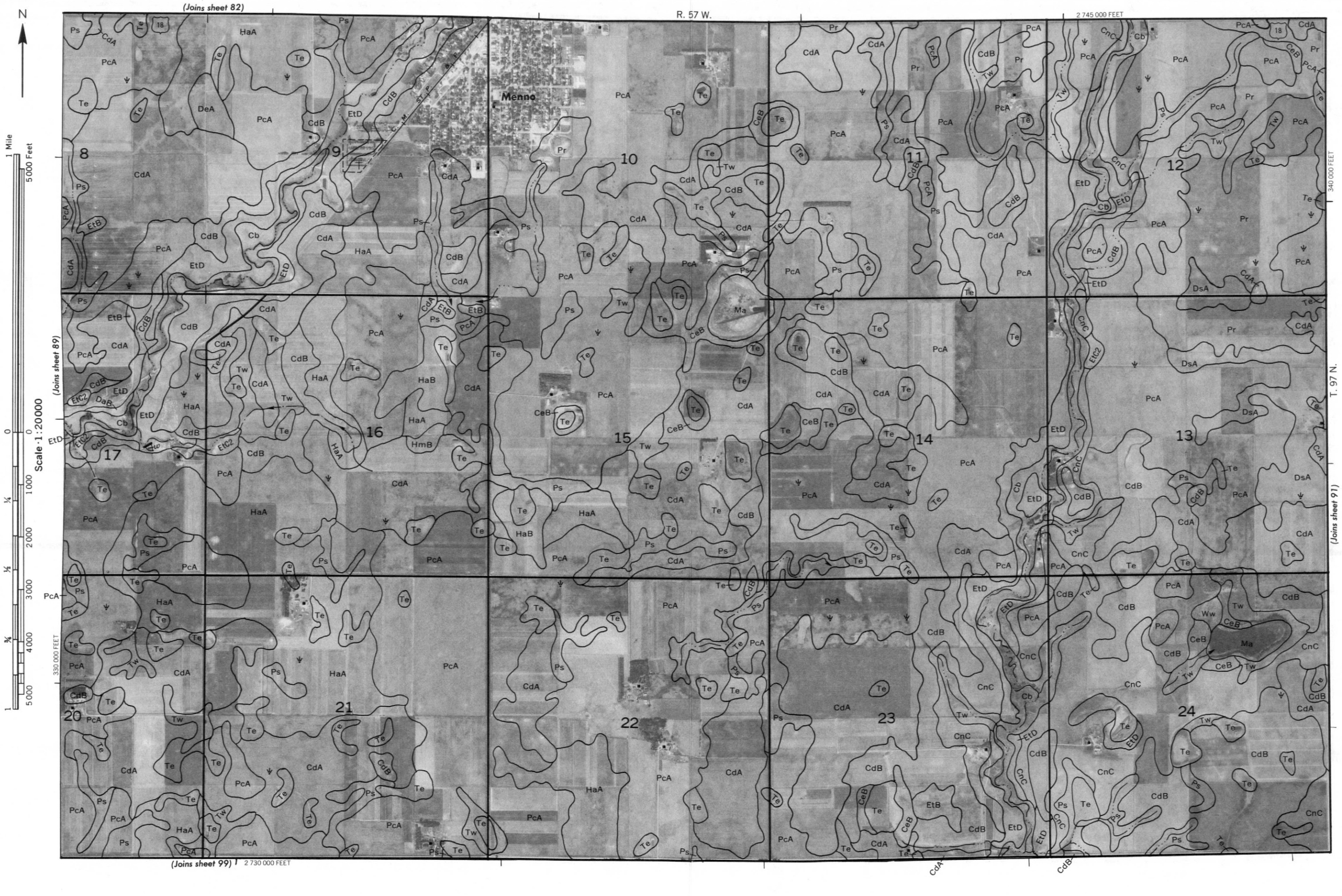
Branch

South Branch

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

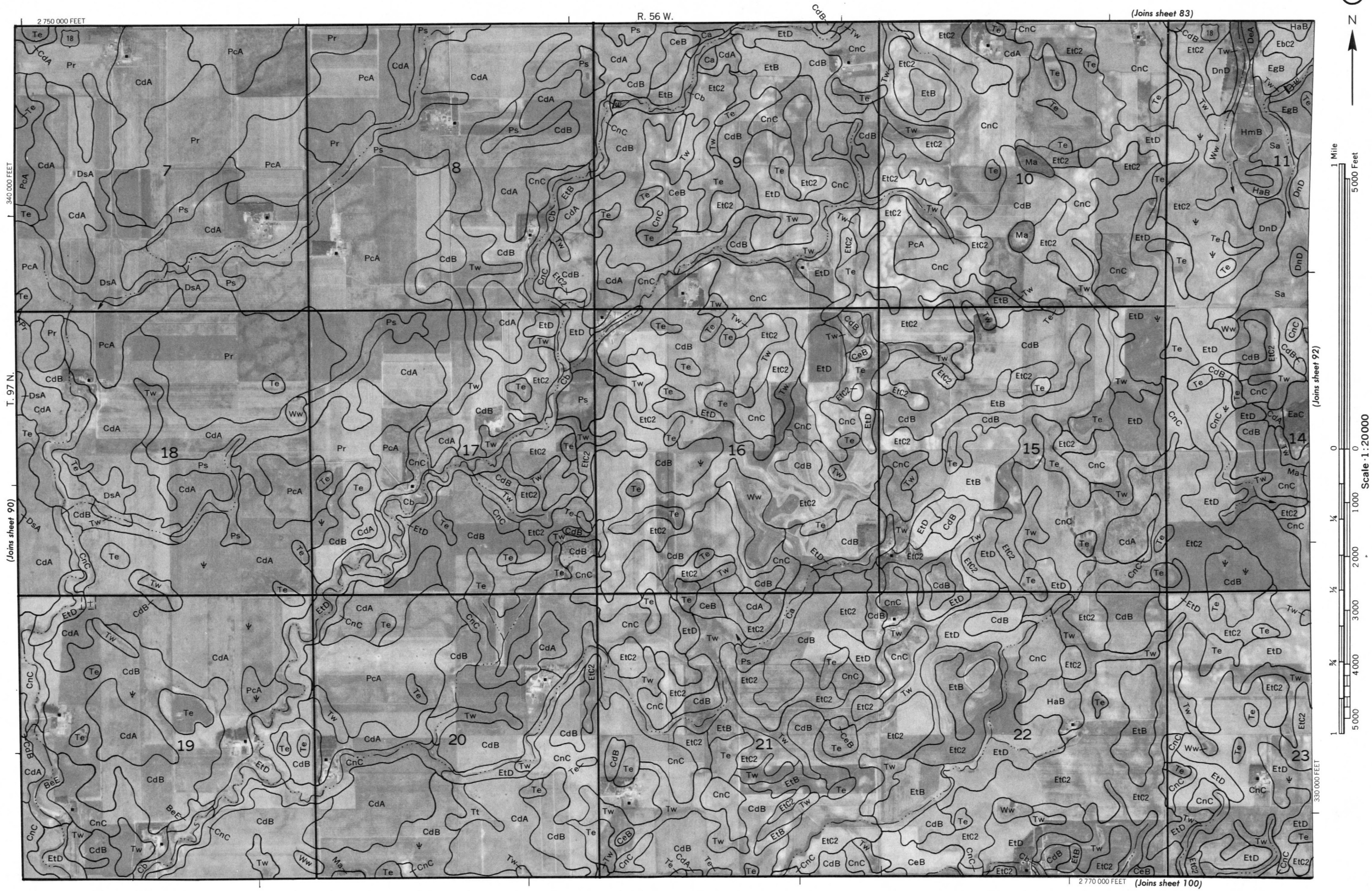
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 89

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



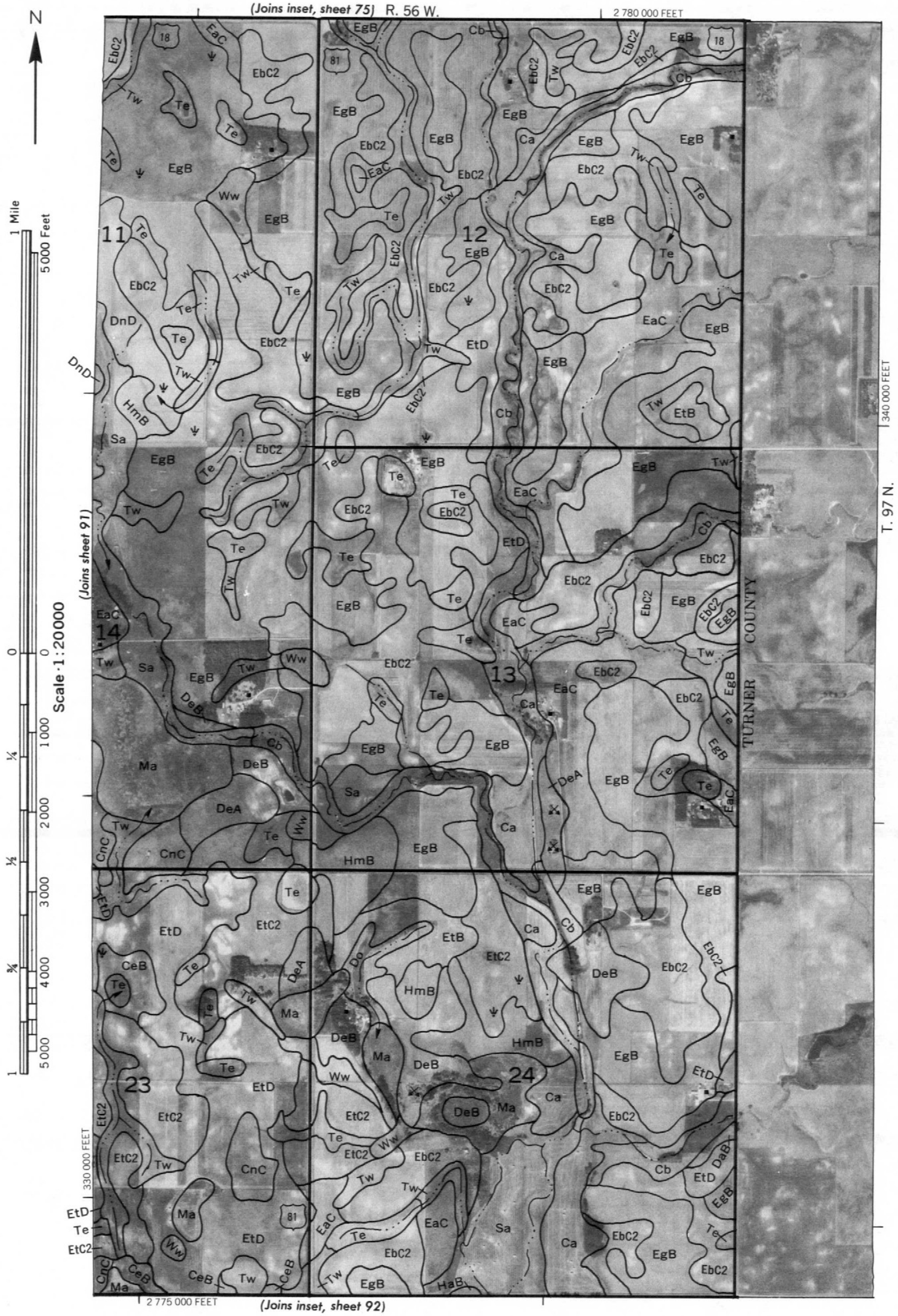
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

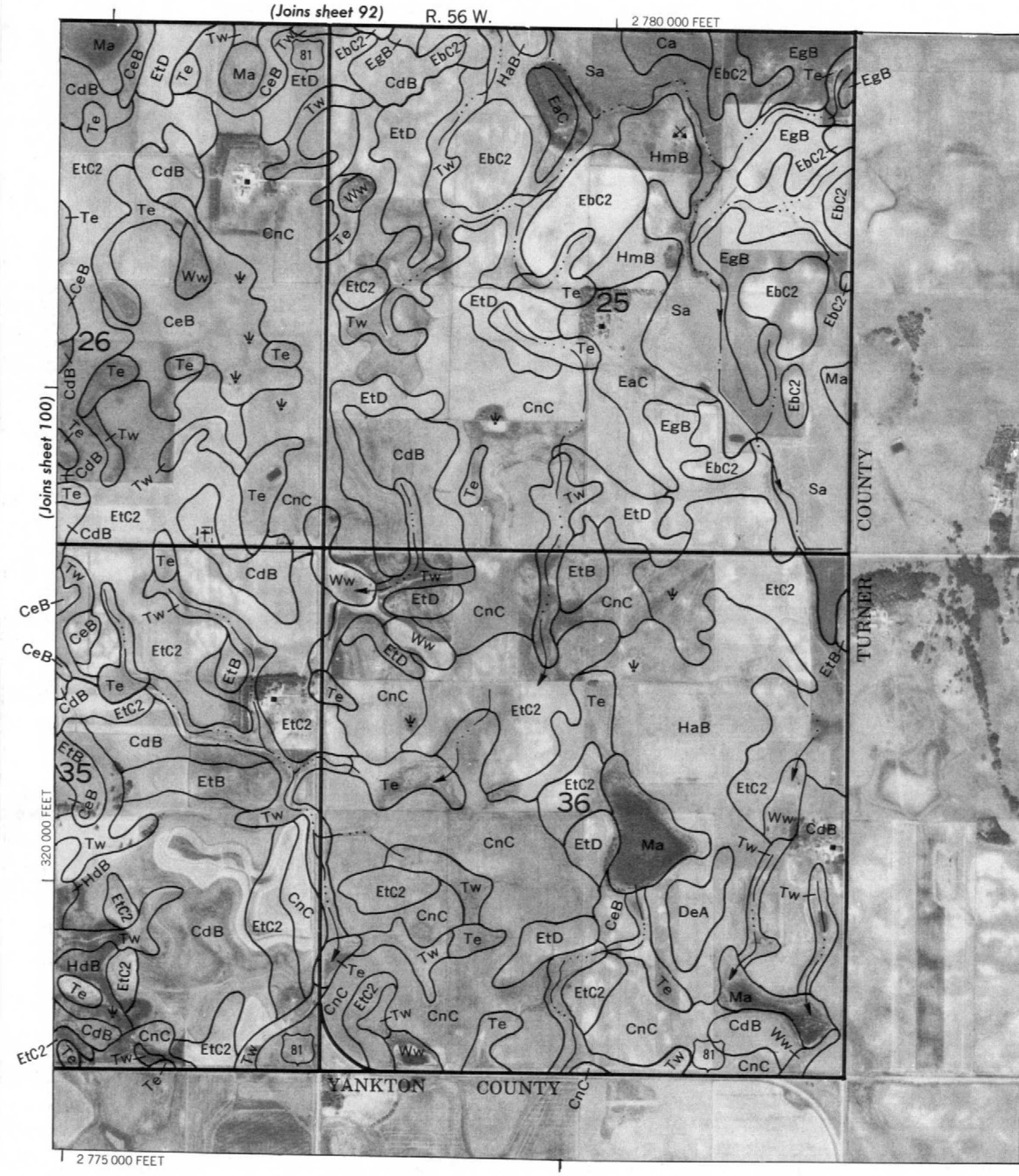
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 90



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 91

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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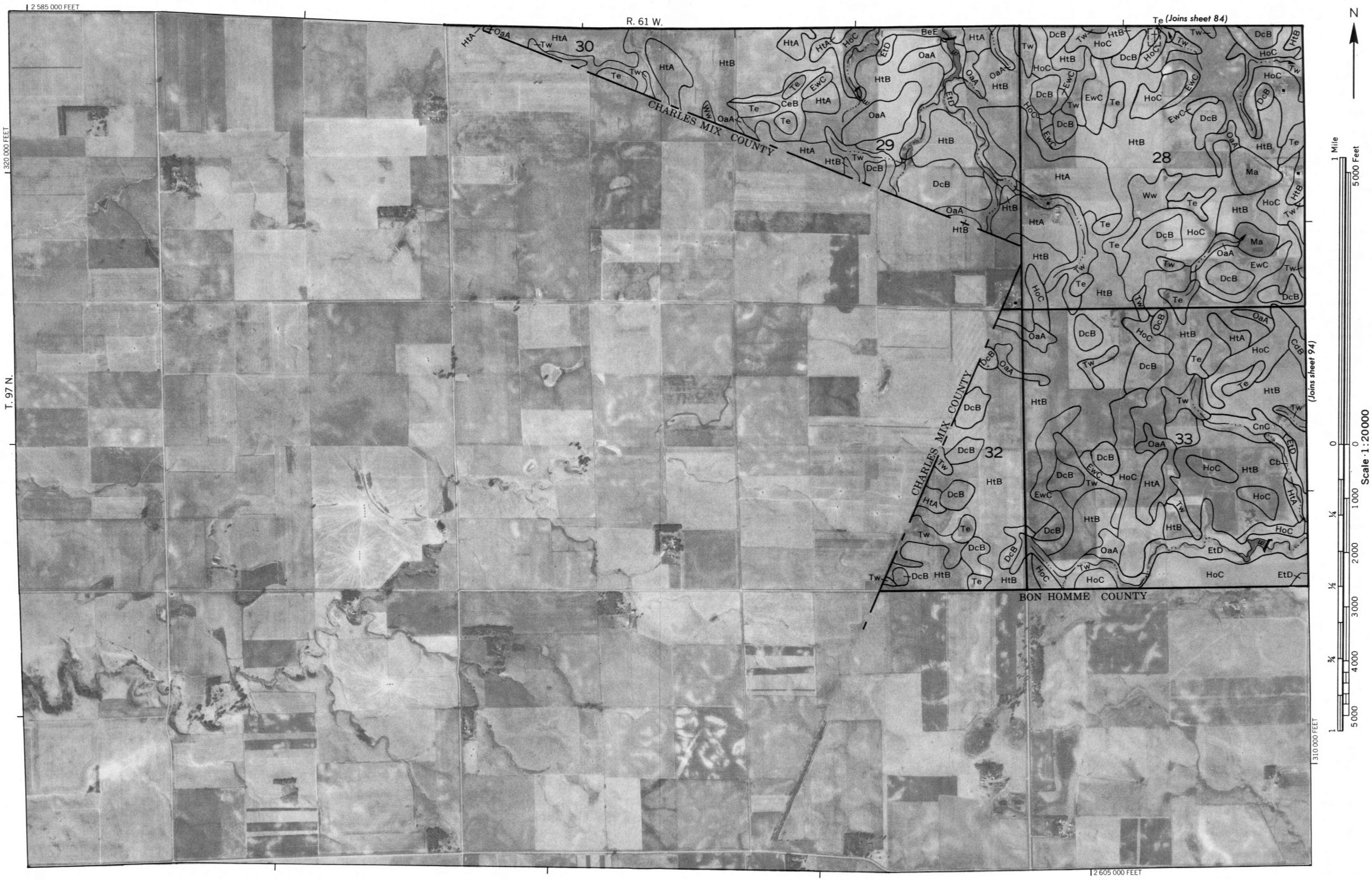
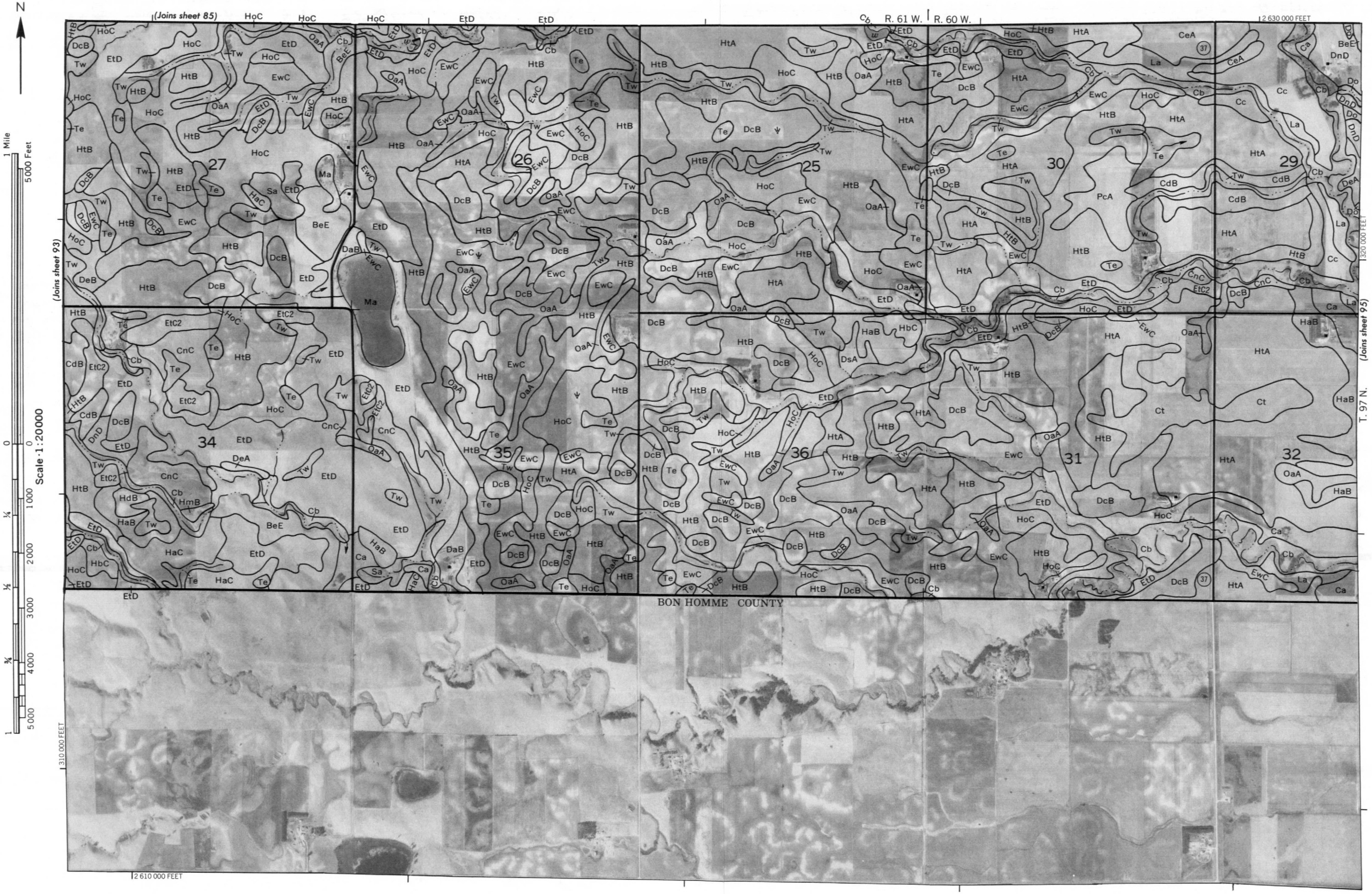


HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 93

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 94



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

Scale 1:20000

1 Mile

5000 Feet

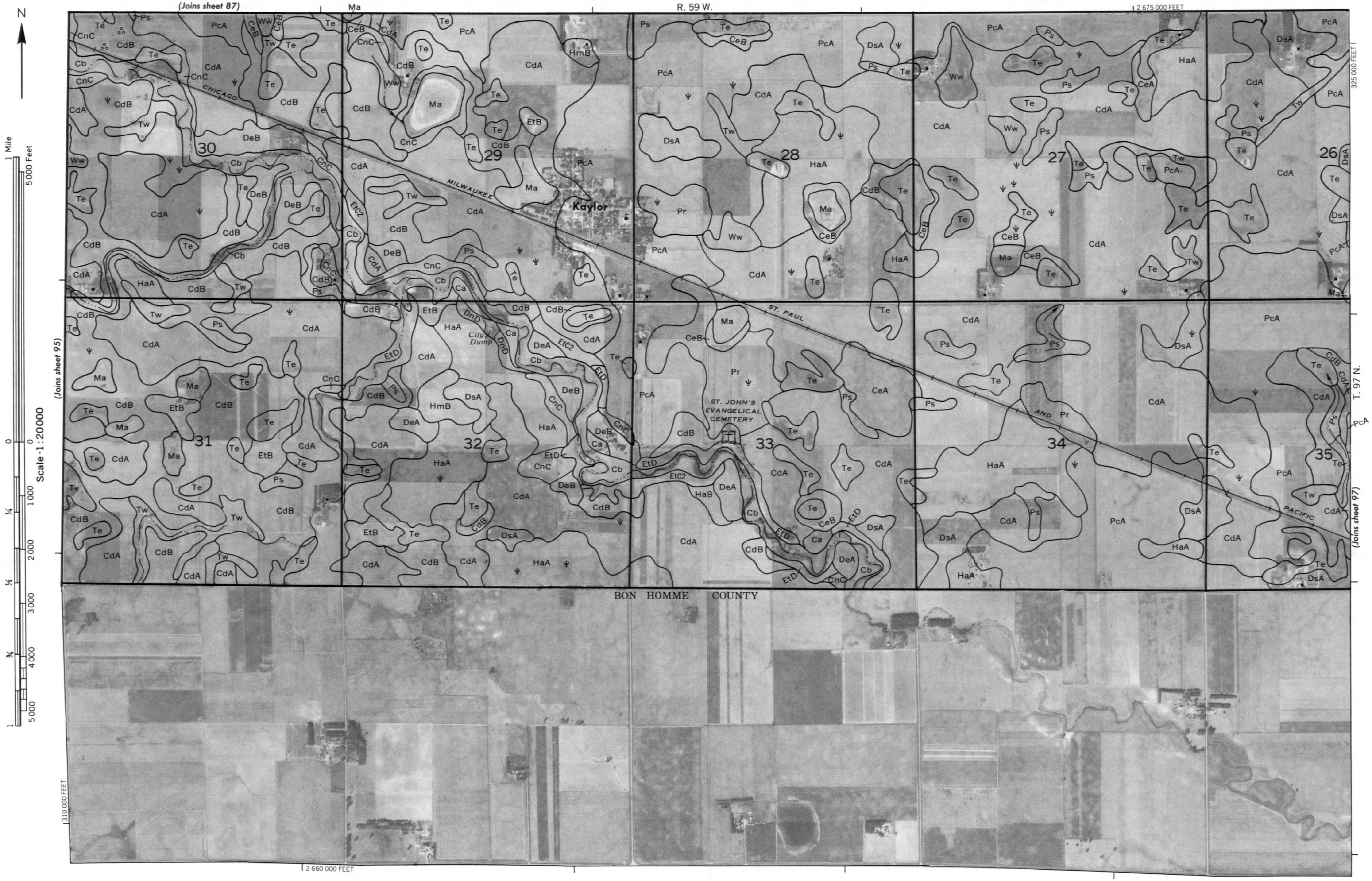
0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

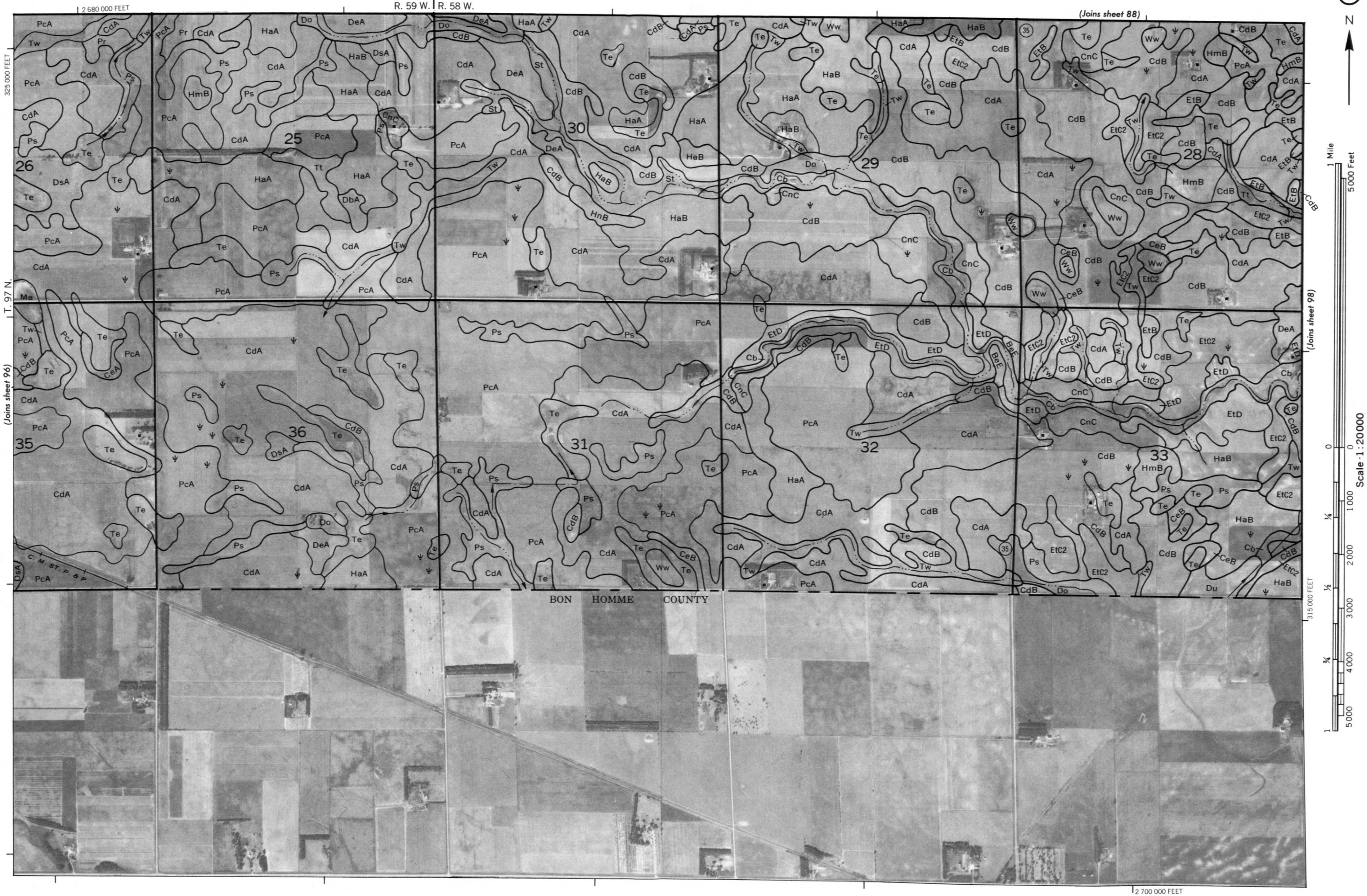
HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 95

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 96



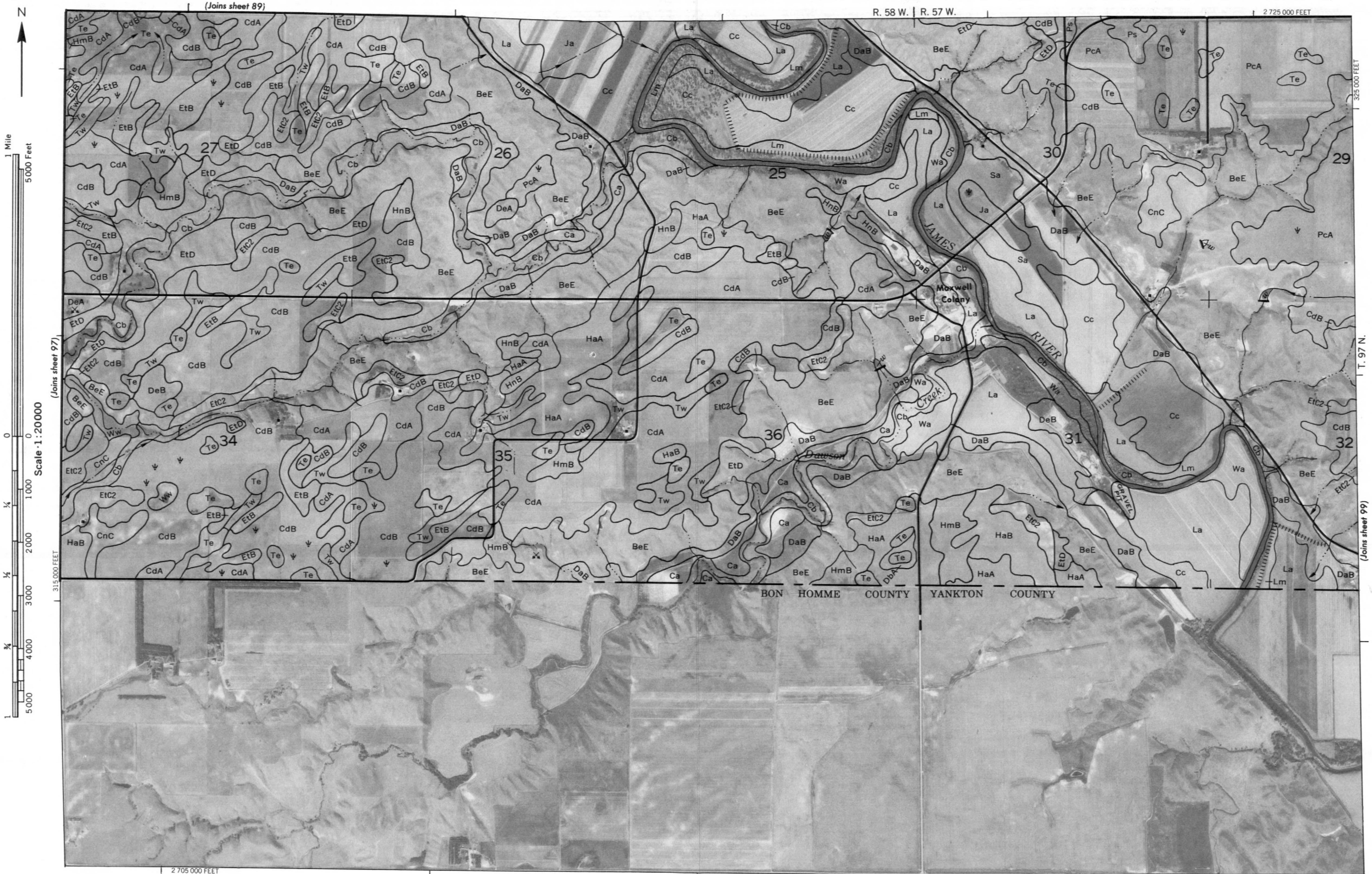
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 97

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON AND HUTCHINSON COUNTIES, SOUTH DAKOTA — SHEET NUMBER 98



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HANSON & HUTCHINSON COUNTIES, SOUTH DAKOTA NO. 99

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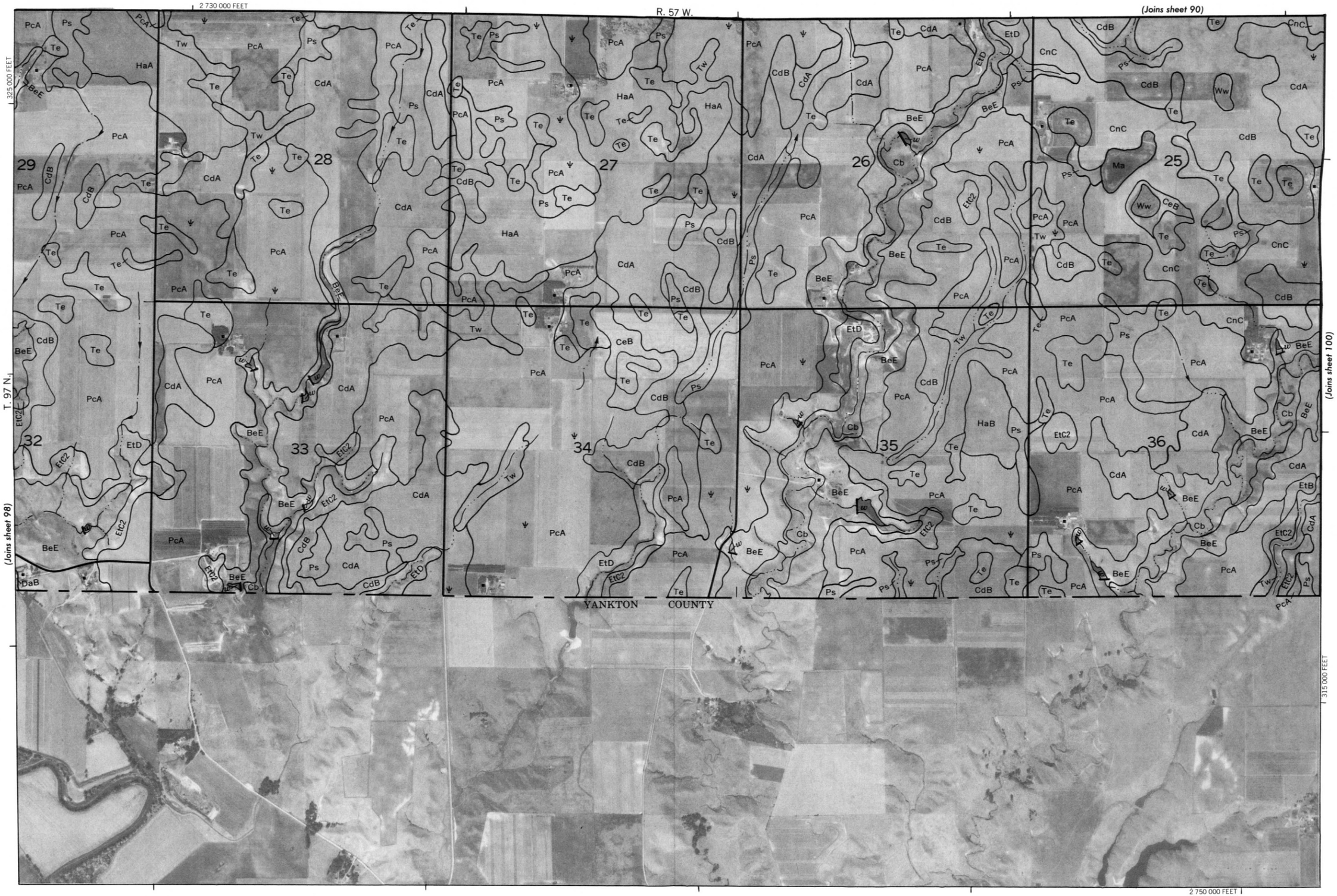

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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